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PRINCIPLES OF OPTICAL DESIGN IN LIGHTHOUSE PRACTICE

By DR. W. M. HAMPTON

THE optical systems used for lighthouses should be of general interest to the glass industry since their manufacture is so specialized and has been conducted under such conditions of secrecy, as to limit knowledge concerning it to a privileged few.

Lighthouses have been known and used since the earliest days of history. There is reason to suppose that that wonder of the ancients—the Colossus of Rhodes—was used for the guidance of mariners. This monstrous figure carried a light in its uplifted hand in much the same way as the statue of Liberty in New York harbor does today. Some idea of its size may be gauged from the fact that when the brass of which it was made, was sold nine hundred years after its fall in 250 B.C., the price was equivalent to $180,000. A second of the Seven Wonders of the ancient world was also a lighthouse—the Pharos of Alexandria. This was built on the island of Pharos by the order of Ptolemy II who insisted that his name should be engraved on the base. The architect, Sostratus, perforce agreed, but took the precaution of carving his own name on the stone under the mortar casing so that in the course of years the name of Ptolomy washed away and that of the designer remained.

These beacons had no optical systems. The lights consisted of wood fires and must frequently have been masked by their own smoke and put out by inclement weather. It was not until 1822 that coal fires—a later development of the wood fire—ceased as an illuminant for lighthouses.

The next step was to make use of the known reflecting power of mirrors to increase the effect in the desired direction. The first record of their use relates to the Mersey Liverpool, England, where reflectors consisting of small pieces of silvered glass built up into a rough paraboloidal shape, were used by Hutchinson in 1753. Following this, silvered copper reflectors, made by heating cut sheet metal by hand to the required shape, were employed; as, for instance, in the Eddystone in 1810.

The greatest advance, and the one of most interest to the glass industry, was made when Augustine Fresnel, the famous French mathematician, invented the stepped lens in 1822. It was well-known that the ordinary bull's eye lens would give an approximately parallel beam when used with a small light source at its focus, but the difficulties of making lenses of the requisite size were, and still are to some extent, so great as to prevent their application to lighthouse practice. Fresnel conceived the idea of dividing up the lens into zones (Fig. 2) which could be made separately and with an accuracy impossible for the solid lens. This system has persisted in principle to the present day through numerous modifications and improvements have been added, such as the reflecting prism for revolving lights invented by Thomas Stevenson, 1850, and the dioptric mirror by Sir James Chance, 1860, both of which make use of the total reflection of light at the inside of a glass surface when the angle of incidence exceeds the critical angle.

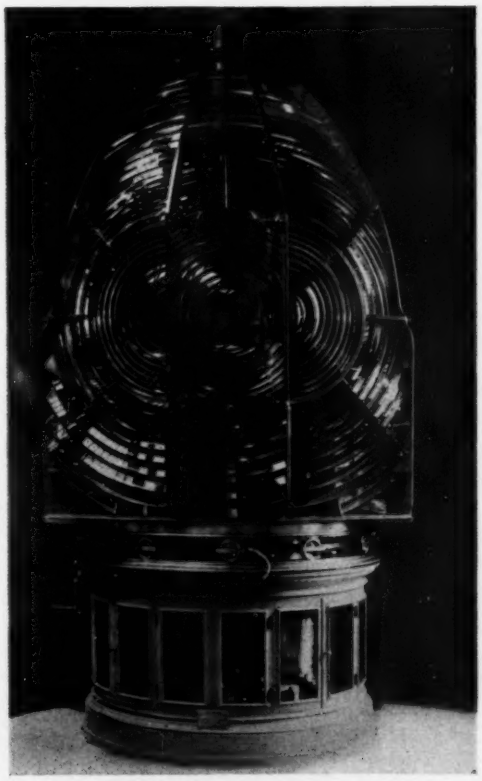


Fig. 1. Group Flashing Lens.

It was Fresnel who introduced the nomenclature which still is used, namely, 1st, 2nd, and so on, orders of lights. The order of the light is defined by the focal length of the lens system; thus a 1st order has a focal length of 920 mm., a 2nd order of 700 mm., 3rd,

500 mm., 4th, 250 mm., and so on. (Fig. 3).

A question that is frequently met in discussions on lighthouse optics by visitors who are not *au fait* with general physical science is this: If a light source having a candle power of, say, 100 candles, is used as a source, how can a beam candle power of several thousand or even millions be produced from it? The question is caused, of course, by a misunderstanding of the terms used. The original source has, one may suppose, a candle power, or more correctly a luminous intensity of 100 candles *in all directions in space*. The beam from the lens gives the same effect *in certain directions only* as a light source of much increased power. That is, the lens is a means of taking light from one position of space and redirecting it in another more useful direction.

Thus a drum lens—or in lighthouse practice, a fixed lens—takes light emitted at angles up to as high a figure as 70 to 80° above and below the horizontal and re-emits it in a horizontal direction. The total quantity of light is never more (in fact, always less, due to absorption and reflection by the glass) in the beam than is given out by the source; but the intensity—lumens per unit solid angle—is much increased. The drum lens, since it is generated about a vertical axis, concentrates the light into a horizontal sheet; thus an observer on the horizon in any direction in azimuth sees a beam of high intensity, an observer, say at 30° above the horizontal sees nothing, whereas with the original source both observers see the same. A revolving lens—which is generated about a horizontal axis—concentrates the light both horizontally and vertically so that the system emits only a pencil of light, with consequently a much increased intensity. Here, however, the observer on the horizon must be in one particular spot in order to see any light, or alternately the beam must be revolved so that it sweeps the horizon, the observer seeing it when the axis of the beam points in his direction.

To give a character; that is, a definite succession of flashes and dark periods, to a drum lens, it is necessary to occult (screen off temporarily) the light source or to nigresce (shut off at the source) the lamp. With a revolving lens, character is obtained by the combination of the number of beams the apparatus is designed to give and speed of revolution of the lens without the inconvenience of altering the source.

It was stated above that the lens was designed to emit the light horizontally. More strictly one should say the lens is designed to send the axis of the beam horizontally. Any projected beam is conical, in fact, as regards its vertical section, since all practical light sources have finite dimensions. Consider in Fig. 4 that 0 is the center of the light source shown as a circle; then the light from the edges of the source will give a conical beam from any point, such as C, on the lens. The only strictly parallel ray is given by the geometrical centre of the source.

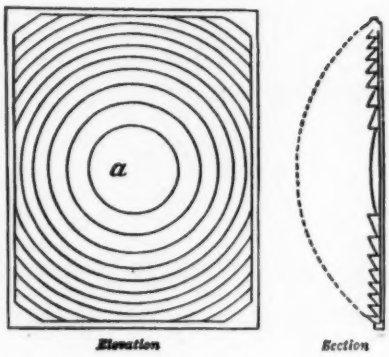


Fig. 2. Fresnel's Lens.

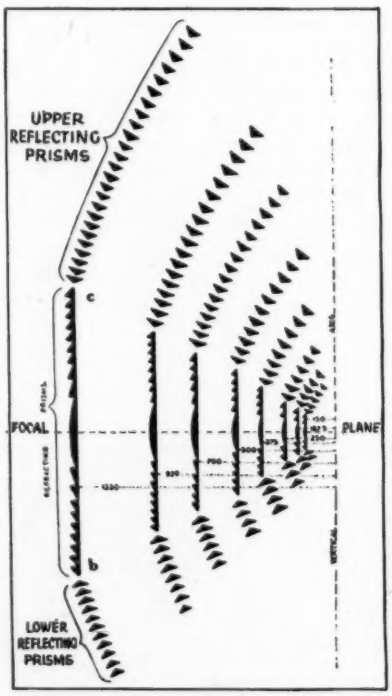


Fig. 3. Different Orders of Lights.

Although lenses are thus designed initially on the assumption that the source is strictly a point, such a source, even if discovered, would be useless; for the intensity of the beam would be zero. Now the deviation of the flash seen by an observer of a revolving lens depends on the speed of rotation of the lens and the angular spread of the beam. With a theoretical point source, the duration would be just nothing and would therefore be invisible no matter how intense it were when stationary. Experience and experiments have shown that for reasonable visibility the flash duration should not be less than 0.1 second and preferably 0.3 second, and since it is usual, and certainly desirable, that the whole light character should be repeated every 10 seconds, it follows that the horizontal angular spread of the beam must be between 3° and 10°. Now the angle of the conical beam depends on the focal length of the lens system and the size of the source so that limiting values for the size of the lamp to be used may be worked out for any order of lighthouse lens. It is this necessity for a flash of definite length which has prevented the general use of arc lamps in marine lights as from other points of view the high brightness of such sources is most desirable.

Similar considerations apply to drum lenses, although in this case there is no question of the duration of the flash being dependent on the size of the source. The equivalent candle power of such a lens is proportional to the width of the source and as a theoretical point has no width, it follows that a point can give no candle power from such a lens.

The importance of these considerations lies in the indication as to the suitability of various types of light source for different lenses which can be deduced. Here, however, we are more interested in the lens than in the light source.

Many varieties of lens form have been designed and used in different lighthouses, both as regards the section

of the lens and in the arrangement of the lenses round the source. Consider first the section of the glass of which the lens is composed. The function of the prism section, as indicated above, is to redirect light emitted by the centre of the source in a horizontal direction. This it does by the refraction of the rays falling on and passing through it. Each face of the prism contributes to the total effect; but the amount of deviation depends on the angle at which light is incident on that face. Thus there is theoretically an infinite variety of prisms, assuming for the moment that the prisms have straight or rather plane faces, which can give the desired result, so that other considerations must govern the choice. Fresnel made the inside face vertical so that the lens was in essence plano convex. This is attractive on the grounds of the compactness of the apparatus and the relative ease of polishing the inside plane face. Stevenson preferred to make the refraction equal on both faces giving the equiangular section. Lenses have been made with the section of the inner face circular about the focus and others with the outer face vertical and therefore plane. Each of these changes brings with it variations in the relative beam spread from an actual source since the angle of the elementary beam given by any point on the lens is different from its initial value after passing the prism. These changes have all been fully explored but, in general, the improvement possible by departing from the Fresnel section is offset by increased complication and cost of manufacture.

It will also be apparent on consideration that the angle of the prism necessary to direct the emergent light horizontally varies continuously as the angle of the incident light alters. The true curves of the various types of prism are extremely complicated mathematically and more complicated still from the manufacturing point of view. Since, however, each prism is relatively small and the light source comparatively large, it is found sufficiently accurate in practice to use the nearest *circular* section which can be found. This circular section is strictly correct at each end of the prism and approximately so over the whole section.

As regards reflecting prisms, there is not such a range of sections available. The direction of the reflecting face is practically fixed by considerations of total internal reflection and the other faces are bounded by the directions of the two extreme rays as more glass than this would not be traversed by the light and would therefore be wasted. The necessary curve can be put on any one or more of the faces; but it is usual to have two straight and one curved for manufacturing reasons. The Fresnel prism had a curve on the longer reflecting side and the Chalmers section a curve on the inside face which receives incidental light. In reflecting prisms, the aberrations or errors are due to the dispersion of the glass, which are obvious in the refractors, are negligible as the directions of the beam in the glass before and after reflection tend to cancel the errors introduced during transmission.

The above discussion deals with the section of the lens along a line from the optical axis to the periphery of the lens. The character of the light; i.e., the alterations of light and dark periods, depends, however, on the natural divergence of the source and lens system, on the speed of rotation and on the relation of the optical axis of the various components of the whole optic—considering only revolving lenses.

The principal of group flashing lights, as these systems are called, was invented by Hopkinson at Birmingham, England, in 1874 and enabled a great increase in the number of characters to be used. As described previously, a flash occurs each time the axis of a beam crosses the observer's eye so that by arranging the panels at unequal angular distances, flashes may be made to occur separated by definite periods of darkness. Fig. 5 shows typical arrangements for group-flashing lenses and indicates how the variable characters are obtained. Particular notice should be paid to the application of mirrors to increase the intensity in the direction of the smaller panels and to avoid stray light in the dark sectors. These mirrors are almost invariably of the dioptric type and it is very surprising to stand behind one of them and find the light source invisible while the only screen consists of glass of remarkable transparency.

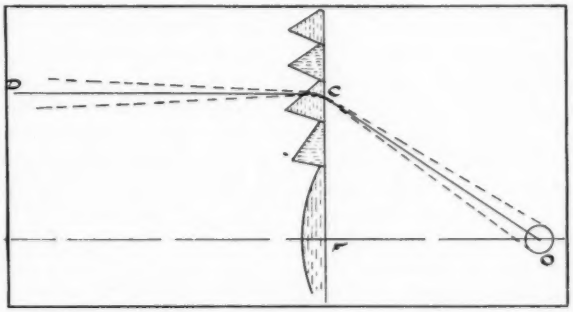


Figure 4.

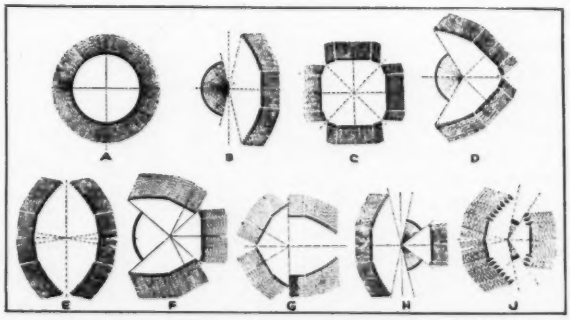


FIG. 5. DIFFERENT REVOLVING LIGHTS

A. Fixed apparatus of 360°. B. Single flashing apparatus (one panel and mirror). C. Single flashing apparatus (four panels). D. Double flashing apparatus (two panels and mirror). E. Double flashing apparatus (two groups each of two panels). F. Triple flashing apparatus (three panels and mirror). G. Quadruple flashing apparatus (four panels). H. Red and white flashing apparatus. J. Apparatus showing a double flash followed by a single flash.

The fundamental idea in the lighthouse design is reliability. It is far more dangerous for a mariner to fail to receive a warning where he expects one than to have no signal available. If he knows there is no light, he proceeds cautiously, but if he goes on expecting one and does not find it, he finds disaster instead. For this reason, only the best possible workmanship and the highest quality materials are acceptable.

REGENERATOR REVERSAL

By Time or Temperature?

IT is the practice in many glass plants to reverse the air regenerator system on a time basis. The time chosen is such as will allow the air used for combustion to become preheated to as high a temperature as commercially possible, thus insuring accelerated combustion, high flame temperatures and more efficient utilization of the fuel. The temperature obtained and the maintenance of a uniform temperature in the furnace therefore depends largely upon the degree of preheat given to the air by the regenerator system. If, then, for any reason the two sets of regenerators become thermally unbalanced, the degree of preheat from each generator will be different and at each reversal the furnace temperature will vary.

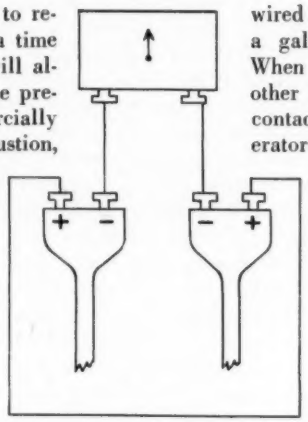


Fig. 1. Method of connecting thermocouples for use in temperature differential method.

There are several factors that contribute to throwing a regenerator system out of balance. The heat capacity and the heat transfer of the brick used in the checkers depend upon their age and physical condition. With respect to the latter, the bricks become glazed, eroded or covered with slag deposits. In the matter of ageing, it is common experience that the two regenerators do not age equally and the capacity for heat of the one is continually varying from that of the other. In time, the entire system becomes thermally unbalanced.

Even when new regenerators are constructed the two sets sometimes show radically different heat capacities, one side reaching the temperature limit much more quickly than the other. When the time reversals are carried out manually, the human element contributes still another unbalancing factor. If the furnace man does not reverse his regenerators strictly on schedule, but does so at irregular intervals, the regenerators become heated unequally and considerable time will elapse before the temperature becomes properly adjusted.

While the method of reversing at standardized intervals is simple and permits of a standardized procedure, actually it defeats its main purpose, as there are times when the regenerators become so badly unbalanced that serious adjustments must be made in the firing system in order to maintain the proper furnace temperature. The reversal period should therefore be variable rather than fixed and it should vary with changing conditions in the entire furnace system. These requirements are met when the regenerator system is reversed on a basis of temperature.

Reversal on a temperature basis is accomplished by the use of pyrometric installations employing methods such as the temperature differential or the predetermined high temperature. The installations use either warning signals as in the case of manual reversal, or relays, where the system may be reversed automatically.

In the temperature differential method a thermocouple is installed in each regenerator or flue. The couples are wired as shown in Fig. 1 and are connected to a galvanometer or a special type recorder. When the temperature of one couple exceeds the other by a pre-determined number of degrees, contact is made with the relay and the regenerators reversed. This method of temperature reversal has the one advantage of not limiting or preventing the temperature in the regenerator from going too high. This can be remedied by the use of auxiliary thermocouples placed in the checkers for measuring the actual regenerator temperature.

In the predetermined high or maximum temperature method a thermocouple is placed in each regenerator or flue and connected in the usual manner to a two point control type recorder. When the side heating up reaches a predetermined temperature, contact is made as in the temperature differential method and the furnace reversed. A variation of this method is to place in the stack a single gas thermometer (if the temperature being measured is not too high) or a single thermocouple. Reversal is made when the stack temperature reaches a predetermined high value. The method of reversing on a predetermined high temperature basis has the advantage over the temperature differential method of being less costly to install and is comparatively simple to operate.

The use of either method requires that the thermocouples be properly located. In many cases, when placed in the walls of the regenerators a true average temperature is not obtained. This is especially true if the furnace is of the cross-fire type and more than one burner is

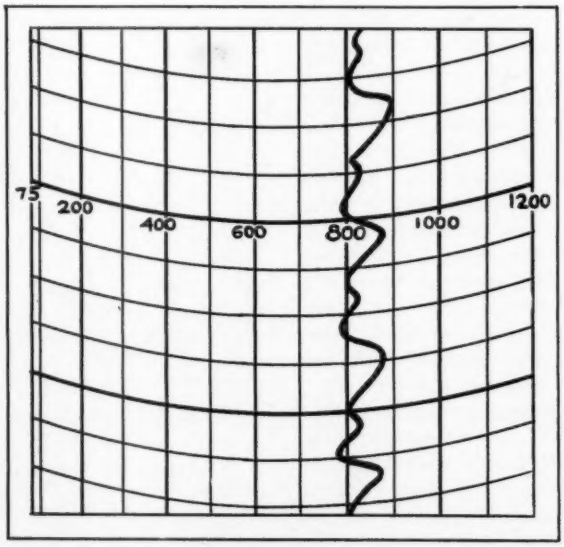


Fig. 2. Showing variation in stack temperature when reversing on a time basis.

used. In this case the couple will measure only the temperature of the waste gas from the nearest burner. Whenever practical, the couples should be placed in the air flues just outside of the cold end walls of the regenerator chambers. At this point the waste gases are at a true average temperature; for in passing from the furnace through the regenerator chambers and the flues below the chambers, the gases become well mixed.

The temperature at which the reversal should take place depends upon several factors; such as the checker design, the furnace temperature, the allowable stack temperature and the location of the thermocouples. The reversal temperature therefore must be determined for each case by experimentation. When the desired temperature limit is first set it will sometimes be found that the heating time of the two sides will be very unequal. As the two sides begin to become balanced, this time difference will tend to disappear; unless of course conditions in the furnace become greatly changed or there is something radically wrong with the regenerator system.

The advantages of reversing by temperature may be best shown by the following illustrations. Fig. 2 shows the unbalanced condition of a regenerator system (measured by the temperature variations in the stack) when time reversal was employed. Fig. 3 shows the balanced condition of the system after the adoption of temperature reversal. Data taken at the same time showed that the furnace temperature remained more constant and that the fuel consumption decreased after the adoption of the temperature reversal method.

An extremely unbalanced regenerator system is shown in Fig. 4 (a), the flue temperature of the waste gases differing by over 100°F. The same regenerator system after the adoption of temperature reversal is shown in Fig. 4 (b). This heating curve shows that the system is still partly unbalanced, since checker B requires several minutes longer to reach the reversing temperature than checker A. Fig. 4 (c) shows the heating curves of the two sides after becoming balanced. The heating times of the two sides have now become equal.

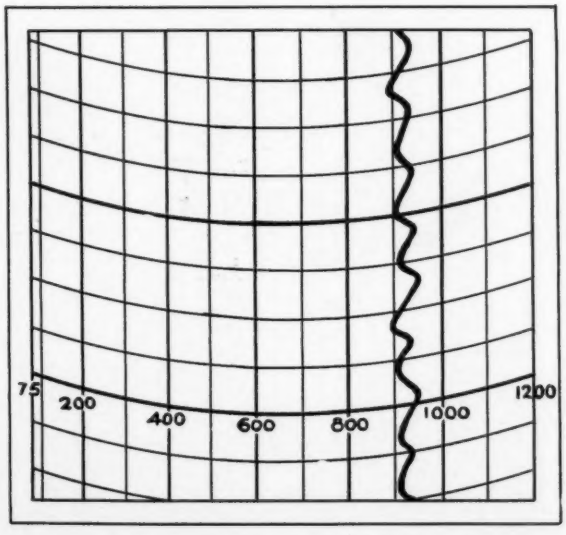


Fig. 3. Showing temperature curve obtained at stack when reversing on a temperature basis.

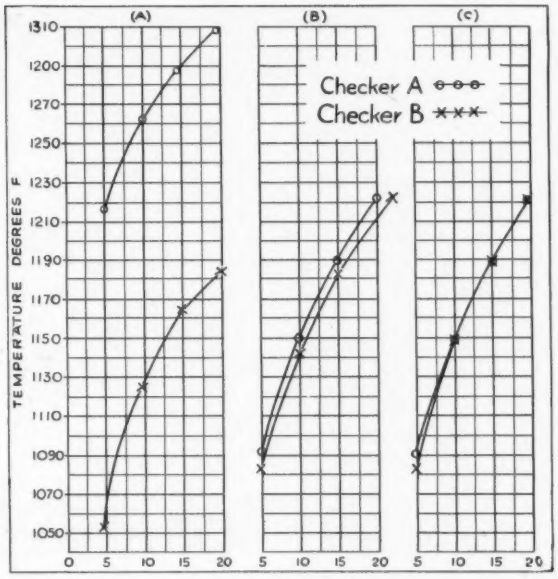


Fig. 4. Heating curves of regenerators. (a) Unbalanced condition, reversing on time; (b) Nearly balanced, reversing on temperature; (c) Balanced, reversing on temperature.

CONFERENCE ON GLASS PROBLEMS

A conference on glass problems will be held June 1 and 2 at Urbana, Illinois, under the auspices of the Department of Ceramic Engineering, University of Illinois, and the Chicago Section of the American Ceramic Society. The program for Friday, June 1, follows:

Observations on Some Important Properties of Glass House Refractories. J. W. Wright, Owens-Illinois Glass Co.

Researches on Glass Conducted in the Department of Chemical Engineering. C. W. Parmelee, Urbana.

The Production of Glass Wool as a Problem in Glass Technology. C. F. Freyling, State Geological Survey.

Following the presentation of these papers, Mr. Freyling will give a demonstration of the preparation of glass wool, and a visit will be made to the laboratories of the Department and the Geological Survey. An informal dinner will be held, after which Professor C. T. Knipp will give a lecture and demonstration of "High Vacua Electrical Discharge Phenomina".

Saturday's session will include the following papers:

The Benefits of the Use of Alumina in Commercial Glass. Robert Ferguson, Pittsburgh.

Surface Tension of Molten Glass by the Dipping Method. R. G. Hunter, Owens-Illinois Glass Co.

Surface Tension of Molten Glass by the Jaeger Method. C. W. Parmelee and K. C. Lyon, Urbana.

The Specific Heat of Molten Glass. A. E. Badger.

PLATE GLASS PRODUCTION

The total production of Polished Plate Glass by the member Companies of the Plate Glass Manufacturers Association for the month of April 1934 was 8,629,381 sq. ft., as compared to 9,926,859 sq. ft. produced by the same companies in the preceding month, March 1934, and 4,679,776 sq. ft. produced in the corresponding month last year, April 1933.

TRENDS IN LIGHTING GLASSWARE

Recent improvement and new technique in the manufacture of lighting glassware and new Mazda Lamps are causing a revolution in methods of lighting in schools, offices and public buildings. Instead of *just* lighting the lighting of the future will be *lighting for seeing.*

The Columbia University new Library will be an outstanding example pointing to what the future will bring. Here a very high level of illumination is produced with an entire absence of glare and annoying brightnesses. This effect is accomplished by the new Galax Glass developed by the Macbeth-Evans Glass Company. Mr. George Ainsworth, prominent Illuminating Expert and Designer, realizing the possibilities of this new glass, developed an entire new line of lighting fixtures which are now marketed by the Westinghouse Company under the trade name of "Magnalux."

The Columbia University Library will be lighted by twenty four inch decorated hyperbola shaped basins. These basins are primarily reflectors to diffuse the major portion of the light upward throughout the room, yet to transmit a certain percentage of the light through the basin giving the basin a deep cream tint. This warm tint on the outside gives the units the appearance of a lighted unit, yet the light in the room really comes from a large area of the ceiling. The totally indirect unit or opaque lighting fixture is found to be rather disagreeable under continued use compared to these new units due to the silhouetting contrast with the ceiling.

Although photographs are not available on the Columbia University Library the photograph here shows the general effect which will be achieved.

THE 120-INCH DISC ARRIVES HOME

Many have wondered how it is possible to ship a 200-inch reflector from Corning, N. Y., to California. These pictures show how it was done with the 120-inch disc. This latter is shown (right) being unloaded from a specially constructed, underslung freight car and lifted by a powerful crane to a motor truck.

THE STATISTICAL POSITION OF THE CONTAINER INDUSTRY

By VICTOR L. HALL

GLASS Container Association has completed a comprehensive survey of the shipments, production, and production facilities of this industry. Former statistics issued by the Association represented approximately 92 per cent of the general line east of the Rocky Mountains and only 85.7 per cent of all production for the entire country. However, the figures on the accompanying charts for all practical purposes cover 100 per cent of the entire volume of the country.

The chart below compares shipments with productive capacity. Total capacity, indicated by a line across the top, amounts to 5,600,000 gross per month. The figure is arrived at by using the accepted figure that 9 square feet of melting area is required, on an average, to produce a ton of packed glass. The industry has a total of 211 active tanks with a melting area of 108,889 square feet. This will yield slightly over six billion pounds per year. In addition to these active tanks, there are 33 others which, although fully equipped have not been operated since January 1931 and are not considered in operating schedules. These added 33 tanks may therefore be considered potential capacity, and their melting area is 17,471 square feet.

The heavy black line on this chart indicates shipments by months. The Spring of 1933 reflected the greatest activity of all time, and during the month of May that year the industry shipped 3,898,593 gross. This period from March to June even normally is one of the best shipping seasons in the container industry; but in 1933 the upward trend was artificially stimulated by the general anticipation of price increases and by the shipment of practically four million gross of beer bottles.

When seasonal factors are discounted, the irregular black line may be replaced with a straight line extending uniformly over the year, which is shown on the chart as a series of dashes. Thus, considering the entire year's business as a unit, 1929 is seen to be the best year in the industry's history. Shipments averaged approximately 2,800,000 gross per month, or 49.8 per cent capacity. During the ensuing three depression years, shipments fell steadily off, and for 1932 they averaged 2,245,000 gross per month or 39.7 per cent capacity. In 1933, the abnormal demand already mentioned brought the average back to 2,754 gross or 48.7 per cent capacity.

What of 1934? The curve for the first quarter has mounted sharply, and the average has been slightly better than a year ago, or 49.5. Liquor ware had much to do with this showing. However, this has already tapered

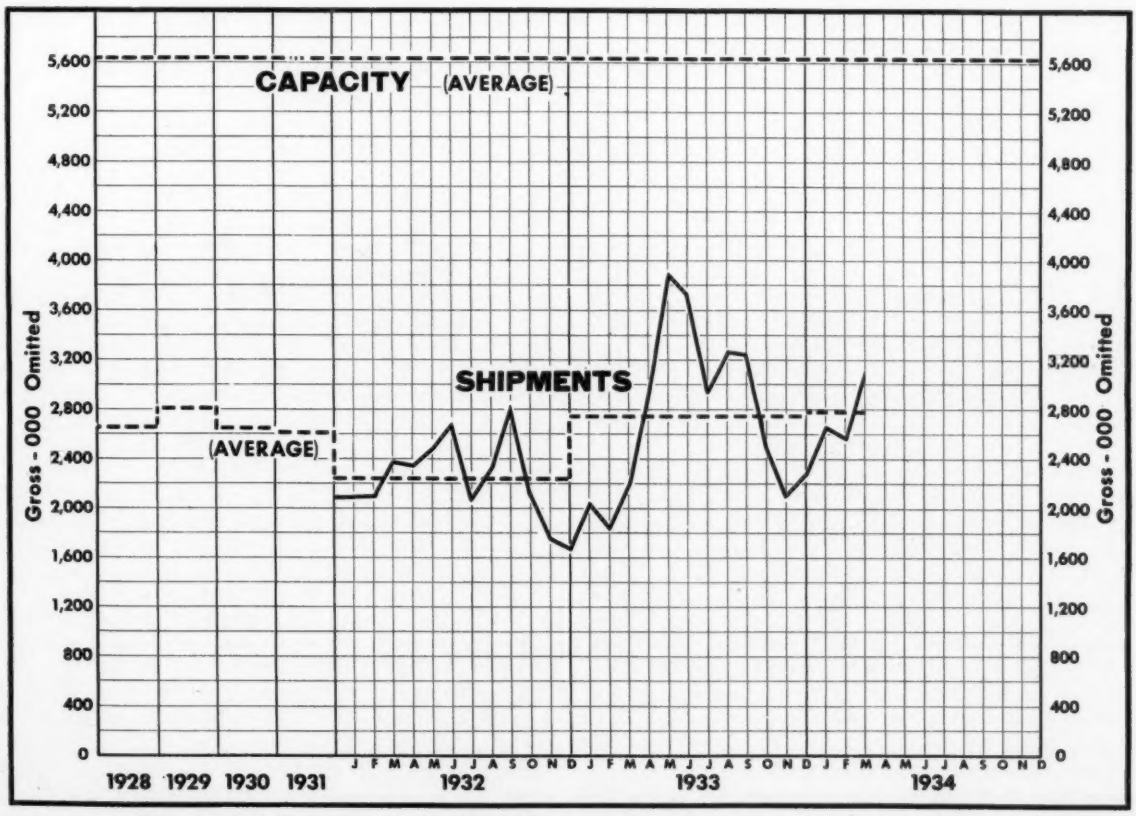


Fig. 1. Total shipments of the Glass Container Industry compared with its productive capacity.

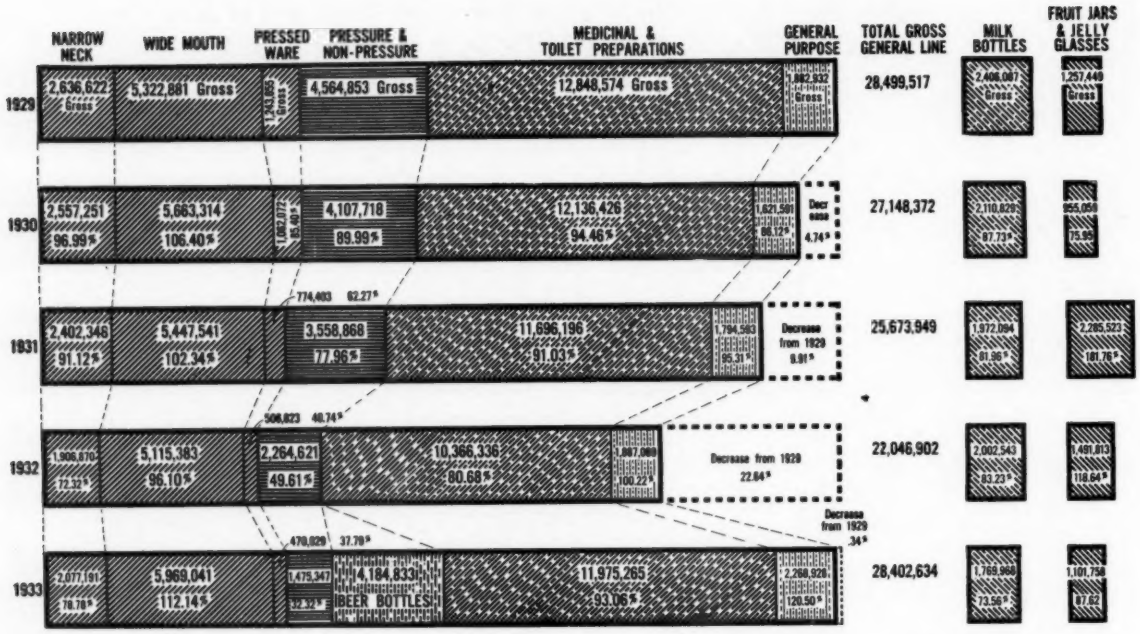


Fig. 2. Comparison of shipments by classes east of the Rocky Mountains, by years since 1929.

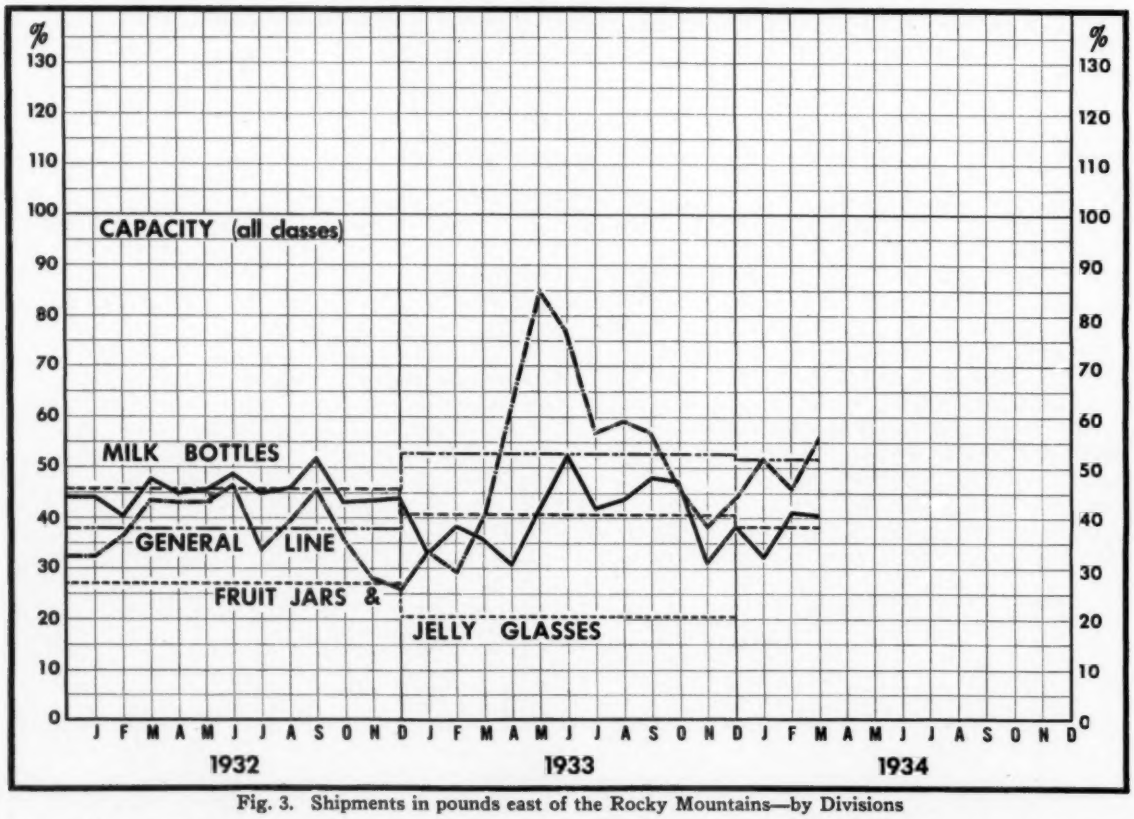
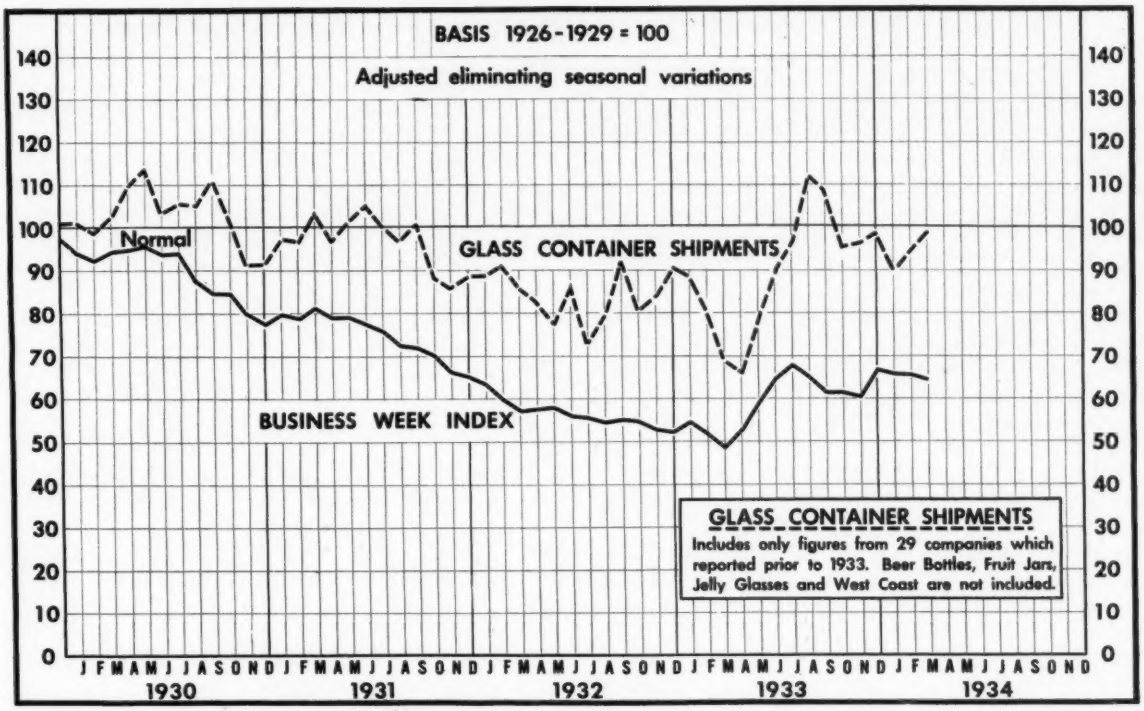


Fig. 3. Shipments in pounds east of the Rocky Mountains—by Divisions

off, and there will be nothing like as big a volume of beer bottles to keep the curve pointing upward at its present angle. Food containers, always highly important at this season, likewise are expected to be weaker, since these bear a relation to seasonal crops, for which the outlook is rather uncertain.

Turning now to the second chart, we see shipments broken down into the three principal manufacturing divisions; General Line, Milk Bottles, Fruit Jar and Jelly Glasses. For 1932, General Line shipments totaled 38 per cent capacity, while in 1933 the figure moved up to 52.8 per cent. Milk bottles have declined


BASIS 1926-1929 = 100
Adjusted eliminating seasonal variations
Normal
GLASS CONTAINER SHIPMENTS
BUSINESS WEEK INDEX
GLASS CONTAINER SHIPMENTS
Includes only figures from 29 companies which reported prior to 1933. Beer Bottles, Fruit Jars, Jelly Glasses and West Coast are not included.
140
130
120
110
100
90
80
70
60
50
40
30
20
10
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J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1930
1931
1932
1933
1934

Fig. 4. Comparison of glass container shipments with general business activity.

from 45.8 in 1932 to 40.7 in 1933, and the first quarter of 1934 they dropped still lower to 38.3 per cent. Figures for Fruit Jar and Jelly Glasses are shown only as average, since virtually all shipments are made during the second and third quarters. These have declined from 27.3 to 20.8 per cent.

The remaining charts are almost self-explanatory. However, in comparing the trend of glass container shipments with the general index of business, it should be remembered that the curve prior to 1933 was not complete for the entire industry, as has already been noted. Figures after that date, therefore, have been confined to the original 29 companies reporting, and other factors, such as beer and West Coast production, have been eliminated.

It is interesting to note that the Glass Container volume has followed very closely the trend of general business through the years 1930, 1931 and 1932. Then for 1933, while the Business Week curve turns upward in April our Glass Container curve started upward with May and continued upward during August, whereas, the Business Week curve reached the peak in July and declined during August. The curve further shows that the Glass Container volume exclusive of the lines mentioned showed an increase as compared with 1932 similiar to general business as shown by the Business Week Index.

SOCIETY OF GLASS TECHNOLOGY MEETS

The Society of Glass Technology held its annual meeting at Sheffield, England, on April 18. G. V. Evers was re-elected president for the ensuing year. F. C. Flint, Hazel Atlas Glass Company, was also re-elected American Treasurer.

Two papers were presented: *Note on the Preparation of Sodium Carbonate free from Iron Oxide*, by W. H. Withey, and *The Development of Mechanical Methods of Glass Manufacture in Europe,* by Professor W. E. S. Turner.

SOVIETS WANT GLASSWORKERS

Amtorg Trading Corporation has asked THE GLASS INDUSTRY to find five expert operators on automatic glass-blowing machines for service in the U.S.S.R. Details are given in a classified advertisement. Today the Soviet states are displaying the greatest activity modernizing methods of glass manufacture and particularly in providing a personnel trained to carry it on in the most up-to-date fashion. The experience of several American Engineers with whom we have talked and who have seen service in Russia indicates that the absolute lack of discipline among the workers, such as we know the word, and their lack of a natural mechanical bent, has proven a great obstacle which they uniformly find difficulty in overcoming. But there seems no doubt that Russia would like to build up a real glass manufacturing industry, and except for the problem of its own personnel, she seems to be going about it in a most intelligent manner.

GRADUATES GLASS TECHNOLOGISTS

The New York State College of Ceramics at Alfred University will graduate thirteen men at the 1934 Commencement, June 12th, with the degree of Bachelor of Science in Glass Technology. This is the first class to complete the course in the new department established in 1932.

These graduates are prepared to be of immediate service to the glass industry in laboratory or plant positions, and should develop rapidly into technologists and executives of real worth in this field of manufacturing.

USE OF 8-HYDROXYQUINOLINE

SINCE the first investigations on the precipitation of the various metals by 8-hydroxyquinoline many papers have been written on its uses and possibilities in the analysis of glass and glass making materials.

While 8-hydroxyquinoline may still be termed an expensive reagent (100 grams now cost about $3.50 compared to the 1927 price of $15.00 per 100 grams) its desirable characteristics overshadow its cost. The following methods taken from the literature show the various uses of the reagent. It can be seen from these methods that the use of 8-hydroxyquinoline for various precipitations will materially shorten the time required for the analysis.

1. *Analysis of glasses containing SiO_2; Fe_2O_3; Al_2O_3; CaO; MgO; ZnO and R_2O (after H. Ritter).*

The sample (1 gram) is fused with sodium carbonate and the silica determined in the usual manner. The filtrate is concentrated to 100ml., neutralized to the methyl red end point with ammonium hydroxide and then made strongly acid with acetic acid and 3 grams of sodium acetate added. Bring to a boil and add oxyquinoline acetate solution to precipitate iron oxyquinolate.

The filtrate is then concentrated to 100ml., neutralized with sodium hydroxide, made slightly acid with acetic acid, oxyquinoline acetate solution added and then heated to 60-70°C to precipitate aluminum oxyquinolate.

The filtrate is concentrated to 100-200ml., heated to boiling, ammonium oxalate added and calcium precipitated as the oxalate.

The filtrate from the calcium is concentrated to 100-200ml., made alkaline with sodium hydroxide, 3 grams of sodium tartrate added followed by the addition of oxyquinoline acetate solution. Heat to 60-70°C to precipitate magnesium oxyquinolate.

If zinc is present it will be precipitated along with the aluminum. In this case the separation may be made as follows: the zinc-aluminum oxyquinolate is dissolved in hydrochloric acid, the solution is then made alkaline with sodium hydroxide and 3 grams of sodium tartrate. Heat to 60-70°C to precipitate zinc oxyquinolate. Neutralize the filtrate and then acidify slightly with acetic acid and add 3 grams of sodium acetate. Heat to 60-70°C to precipitate aluminum oxyquinolate.

2. *Rapid Determination of Aluminum Without Previous Separation of Silica (after G. Kruibe).*

Fuse sample in the usual manner with sodium carbonate and dissolve the melt in hydrochloric acid. Neutralize with ammonium hydroxide using methyl orange indicator. Avoid precipitating aluminum hydroxide. Make slightly acid with acetic acid (not more than 0.5ml. free acid per 100ml.) treat in the cold with 3-5 grams of ammonium acetate. Add oxyquinoline solution acetate and heat to 70-80°C. Cool and filter. Wash the precipitate with hot water and then with cold water. Dissolve in hot 1:3 hydrochloric acid and titrate. Determine iron in a separate sample and subtract from the titration.

3. *Determination of the Alkalies (after J. Robitschek).*

The sample is evaporated with hydrofluoric and sulphuric acids. The residue is taken up with hydrochloric acid and hot water. Add in succession, ammonium hydroxide, ammonium oxalate and oxyquinoline acetate solution. Heat to 70°C and then cool. Filter and wash the precipitate with dilute ammonia water. Evaporate the filtrate, convert to sulphates and weigh as the combined sulphates of the alkalies.

4. *Treatment of the Oxyquinolate Precipitates.*

The oxyquinolate precipitates may either be dried or titrated. Table 1 gives the various data necessary to calculate the oxide content of the various quinolates. Table 2 gives the factors for the various oxides when the quinloate are titrated.

TABLE 1

Quinolate Composition	Drying Temperature °C	Factor for Oxide
Iron	120	0.1636
Aluminum	110	0.1110
Magnesium ($2H_2O$)	105	0.1157
Zinc ($1\frac{1}{2}H_2O$)	105	0.2139

TABLE 2

1ml. of N/10 Potassium bromate-bromide solution
= 0.000425 gram Al_2O_3
= 0.000665 " Fe_2O_3
= 0.001020 " ZnO
= 0.000504 " MgO

ALEXANDER SILVERMAN RETURNS

Dr. Alexander Silverman, Head of the Department of Chemistry at the University of Pittsburgh, who was one of ten delegates from the United States to the IX International Congress of Pure and Applied Chemistry and the XI Conference of the International Union of Chemistry, held in Madrid last April, returned recently on the S.S. Paris. During his short stay in the city of Paris after the convention in Madrid, he presented a diploma of honorary membership in the American Ceramic Society to Professor Henri le Chatelier, Dean of French chemists and France's outstanding authority on glass.

While in Paris, Professor Silverman visited the Marchets des Puces or "Flea Market", where the ragpickers of Paris display their wares on Saturday afternoons and Sunday mornings during the spring of the year. For a mere song, Professor Silverman purchased a number of interesting specimens for his glass collection. These include an engraved liqueur bottle; a pair of old candle sticks from the Portieux factory in France; a small casket with a glass mosaic top bearing flowers in relief.

Professor Silverman brought a cast bowl, bearing an ancient frieze in relief, the work of the artists Gueron and Cazaux of Compiegne; a beautiful paper weight with millefiori designs from Baccarat and from the latter factory an all-glass knife, of the type now being generally manufactured for table service.

Accompanying Professor Silverman on the S.S. Paris were the following plate and window glass manufacturers of France and Belgium: Messrs. Eugene Gentil, G. J. Ravel, Gaston Jeanjean, A. A. deValmy Longueville and Daniel Serruys.

A NEW POLARISCOPE

By FRANK W. PRESTON

THE instrument described below was first put into use a couple of years ago; two such instruments have been in use for some time, one in an industrial plant, the other in a laboratory, and as they seem to have been found quite useful, a brief description is now given.

The polariscope is intended for use on glass bottles and other complicated shapes, as well as on drawn sheet and rolled plate, especially if the latter is in the rough state so that detailed inspection is difficult. It is intended for use where more painstaking inspection is thought worth while, as compared with the perfunctory inspection normally given. It is also of use, in connection with a furnace, for determining annealing "constants".

Complex shapes, like bottles, can only be properly inspected in an immersion polariscope, except that a rough idea of the presence of cords may be obtained without immersion, and the appearance of the bottom of the bottle may be used (viewed down the bottle axis through the neck) to see if the bottles are similar to one another.

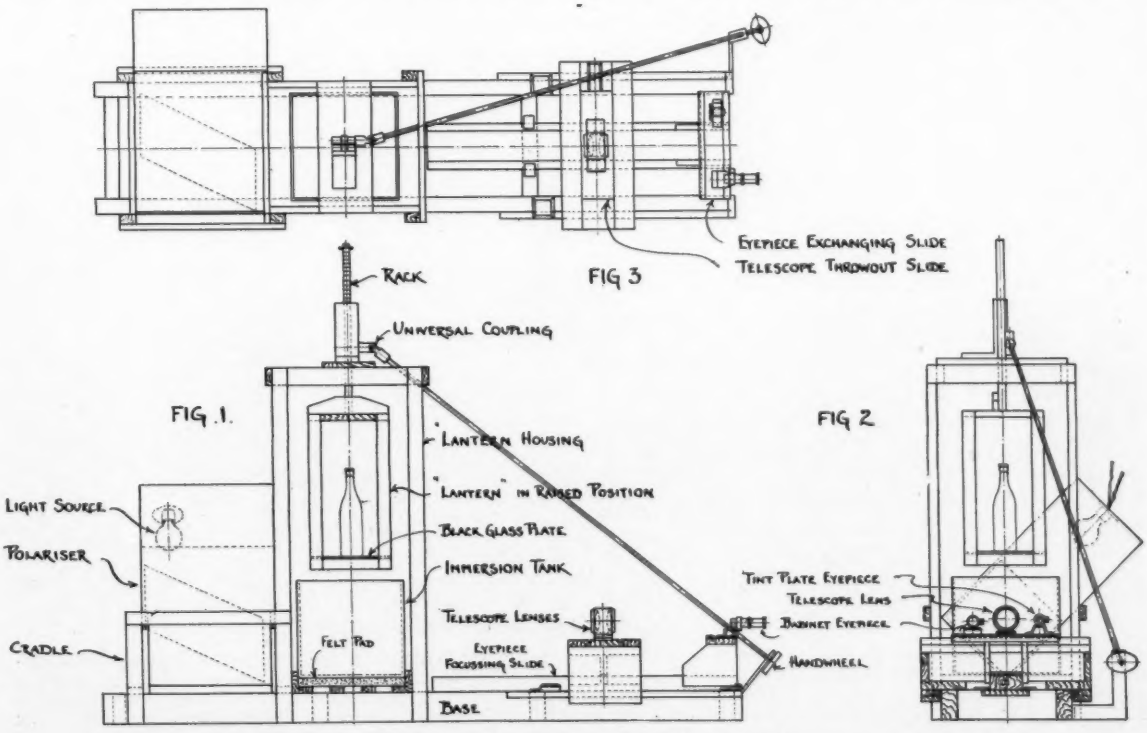
Plate and wire glass should be examined edgewise from time to time; but a diamond cut edge is usually rough, particularly with wire glass, and the appearance misleading unless the cut edges are ground and polished. This is too troublesome. The immersion method obviates the need for polishing.

In some plants the polarizing microscope, with an immersion system and cut sections of the bottle, is used. This is a good way to discover fine *cords*, but it is troublesome and does not give much information about the *annealing* of the bottle as a whole.

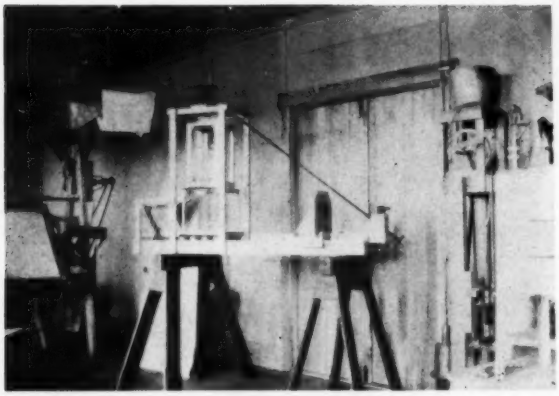
In ordinary immersion polariscopes, as at present used in the industry, the bottle must be held at an angle of 45° to the horizontal to get the proper optical effect. This is a nuisance, and in many cases the operator does not even know that it is necessary. The present polariscope avoids this difficulty by polarizing the light in the first instance at 45° to the horizontal, so that the bottle can sit vertically and show the full color effects. In the same way specimens of plate, sheet, or wire glass can sit flat (horizontally) and show the full optical effect.

For detailed analysis of many problems, a Babinet compensator, giving sidewise displacement of colored lines, is as a rule more intelligible than the simple color effects of the ordinary polariscope. The present polariscope, accordingly, uses a Babinet ocular whenever desired, there being in fact two oculars—the Babinet and the Sensitive Tint Plate—so arranged that either one can be slid instantly into position.

Since the Babinet wedges cannot conveniently be immersed in the immersion fluid, and thus brought close to the glassware being tested, and since it is necessary in this sort of work to have the wedges in sharp focus, a high aperture telescope lens is used to form an *image* of the glassware upon the wedges, and then the stresses can be examined critically. The telescope lenses are mounted on a slide, so that they too can be instantly inserted or



The apparatus viewed from a side elevation (Fig. 1), eyepiece end (Fig. 2) and plan view (Fig. 3).



The apparatus set up and ready for use.

removed. Thus the instrument is usable as four types of polariscope without effort:

1. As an ordirary immersion polariscope.
2. As a dry polariscope, of the ordinary type: the object under examination being placed in front of the immersion tank instead of inside it.
3. As an immersion polariscope with a Babinet analyzer, using the telescopic projection lenses.
4. As a simple Babinet polariscope by removing the telescope lenses and setting the test specimen immediately in front of the Babinet ocular.

As a rule, two quick-change focusing positions are provided, one for examining ware of ordinary dimensions and the other for examining extra thick ware. The method of operation will be clearer from a brief description of the instrument itself.

Figure 1 is a side elevation of the apparatus, Figure 2 a view from the eyepiece end, and Figure 3 a plan view.

The base consists of wooden stringers and cross pieces, and carries at one end a "cradle", consisting of a skeleton framework to hold the polarizing box in position. This box is a complete separate unit, consisting of a lamp bulb, a diffusing screen, and a black glass polarizing sheet. It may be taken out and used entirely apart from the rest of the apparatus, a thing which is sometimes convenient. In its ordinary use it lies in the cradle supports in such a way that the plane of the polarized light is at 45° to the horizontal, and as it will lie on either of the 45° faces, the light may be set for "nicols crossed" or "nicols parallel" with respect to the eyepieces, without disturbing the latter. The parallel position is normally of use only in focusing the eyepiece hair lines.

Next along the base is the "lantern" housing. The "lantern" is simply a sheet metal framework with a black glass base plate on which the glass to be examined can be placed for immersion. A handwheel near the eyepiece permits racking up and down of the lantern parts to bring any part of the specimen into accurate register with the Babinet eyepiece.

Slides are provided for interchanging eyepieces, for inserting or removing the projection (telescope objective) lenses, and for focusing endwise.

The various manners in which the instrument can be used will be obvious to the technologist, and would take too long to explain here. It may, however, be added that by taking away the immerssion tank, a tubular electric furnace can be put in its place (with tube horizontal), and one has immediately a very convenient polariscope for studying annealing temperatures and determining annealing schedules. The "Adams and Williamson constants", for instance, can be found quite readily.

It may perhaps be said that the instrument is a general purpose polariscope, suitable for all sorts of laboratory purposes, and useful also for routine workshop inspections where the latter are not too perfunctory.

A FAMOUS GLASSHOUSE IS REDISCOVERED

An employee of the Hartford-Empire Company recently discovered and brought to light this hitherto unpublished picture of the world-renowned Boston and Sandwich Glass Company. In the days when this factory flourished, outside contact with the world was a rarity. The plant was operated by local residents, and the glass made from Berkshire Hills sand. For fuel, pine and oak were brought from neighboring woods by ox carts. This picture was taken just before the buildings were demolished, in 1904.

IMPROVED REGENERATOR DESIGN

By S. A. FORTER

SINCE the first Siemens regenerative furnace was built about seventy-five years ago, little improvement has been made in its design. Generally the checkers are arranged as in the original Siemens design with vertical, straight or staggered flues. In this conventional setting the flow of the gases or air is not directed through the checker setting to utilize the entire checker volume. Frequently, channeling of the gases occurs as the waste gases or air flow through the hottest or coldest zone of the checker setting.

An ideal checker chamber design and checker setting is one that directs the gases or air uniformly over the whole checker setting. The checker setting must contain the greatest weight of heat absorbing materials per cubic foot possible and at the same time permit sufficient cross section area for the free and uniform flow of the waste gas and air.

The change in specific heat of the waste gases and air, and checker mass at different temperatures should be compensated for by changes in the mass weight per cubic foot of the checker mass. These differences in mass weight per cubic foot, greatest where the temperature differential is greatest and lowest where the temperature differential is low, should permit a constant flow of gas or air.

The function of the regenerator is to absorb heat from the waste gases from the furnace and on reversal to give up heat to the incoming cold air. The ideal regenerator should absorb heat throughout its entire length without materially reducing the velocity of the gases in any section.

Two regenerative furnaces embodying the principles outlined have been installed in a glass plant and have been under observation for several months. The results obtained indicate that this type of checker setting is definitely superior to the conventional setting in common usage today.

These regenerators in use with an end port type glass melting furnace are the horizontal flue type setting illustrated in Figure I. All the data from which a comparison of the operating characteristics of the two types of checker design is made, was obtained from end port tanks.

The checkers are built in banks of straight-non-connecting flues. By the use of banks of flues with space between the banks, it is possible to arrange the checker setting so that there is a progressive reduction in cross sectional area flue area and a progressive increase in checker mass weight as the waste gases decrease in temperature. By this arrangement, the waste gases maintain a more uniform velocity through the regenerator as the decrease in checker cross sectional area and increase in mass weight per cubic foot compensates for the decrease in gas volume as its temperature is lowered by the absorption of heat by the checker mass. When cold air enters the checkers on reversal the increased cross-sectional area and decrease in checker mass aids in maintaining uniform velocity as the air expands as it picks up heat from the hot checker mass.

The purpose of the straight-non-connecting flue is to direct the waste gases and air through the checker mass in a definite path utilizing all the checker mass. The space between the checker banks serves as a mixing chamber for the gases or air prior to their passage through the next bank of checkers. An investigation of the temperature within the check mass disclosed surprisingly uniform temperatures from top to bottom and side to side indicating no channeling of the gases.

In Figures II. and III. curves are presented illustrating data obtained from a study of the Forter re-

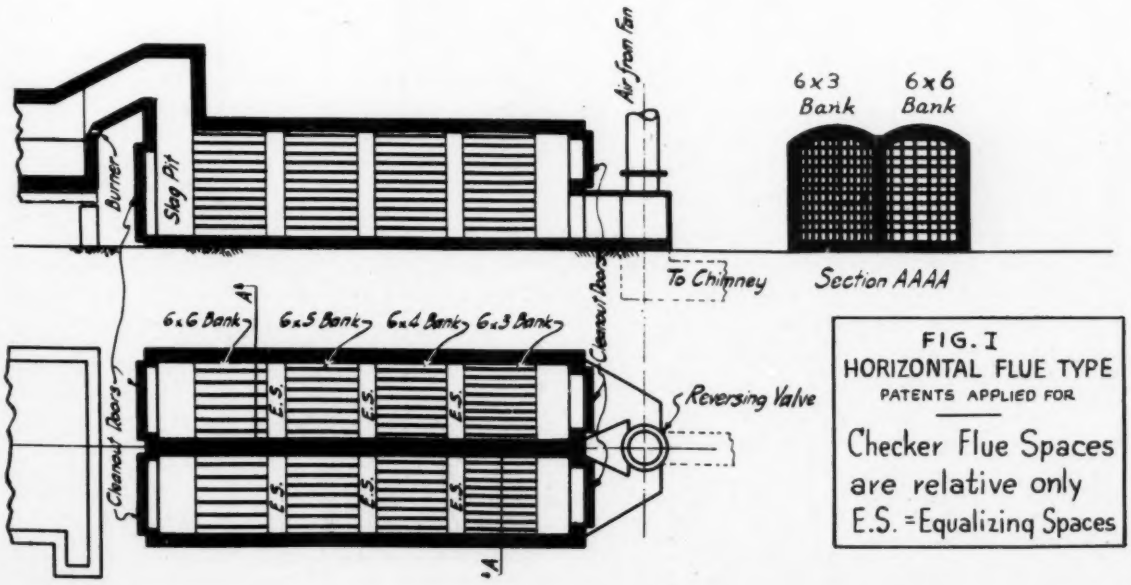
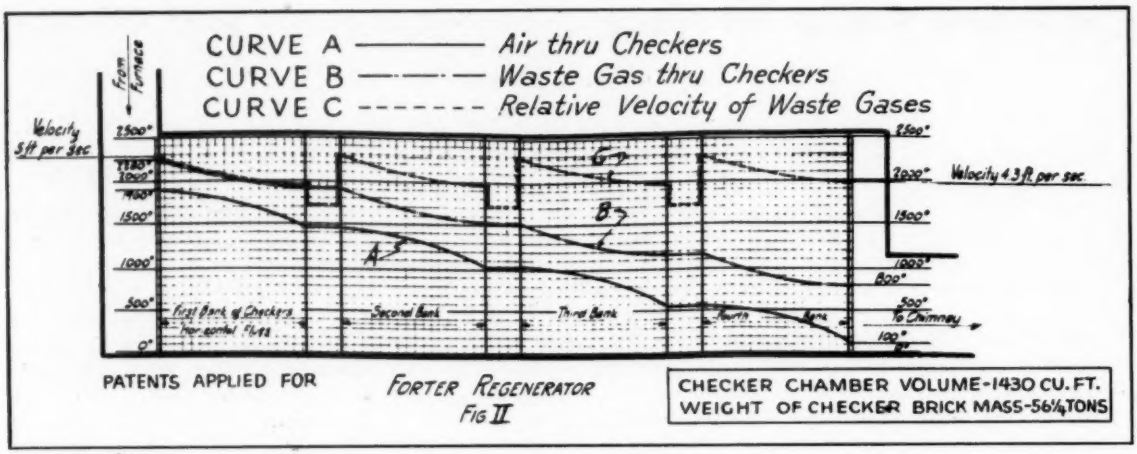


FIG. I
HORIZONTAL FLUE TYPE
PATENTS APPLIED FOR

Checker Flue Spaces are relative only
E.S. = Equalizing Spaces



PATENTS APPLIED FOR

FORTER REGENERATOR
FIG II

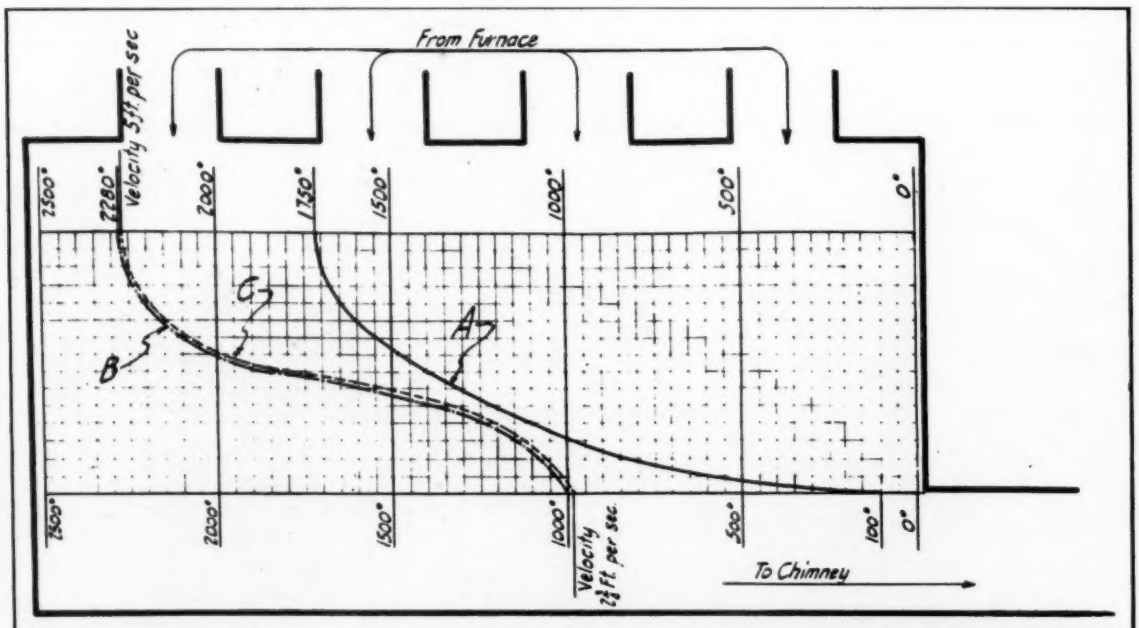
CHECKER CHAMBER VOLUME-1430 CU. FT.
WEIGHT OF CHECKER BRICK MASS-56¼ TONS

generator and the conventional regenerator now in common use. These curves show the changes in temperature of the air and of the waste gases as they pass through the regenerator and the change in velocity of waste gases throughout the regenerator.

The temperatures shown at each end of the regenerators are taken as average temperatures that exists in furnaces under present operation. A comparison of the temperature curves show that in the Forter design the progressive change in each checker bank produces a gradual decrease in waste gas temperature and that all of the regenerator is operative. While in the conventional design the temperature change is rapid in the first section practically no cooling occurs in the last section. The heating of the cold air follows very closely the cooling of the waste gas in the changes of temperature.

This decrease in the cooling of the waste gases in the last portion of checker brick in the conventional type regenerator is attributed to the waste gases passing through a uniform cross sectional area throughout the entire checker setting. As the gases near the end of the regenerator there is not sufficient heat storage capacity in the checker mass to absorb the heat from the waste gases.

It will be noted that the velocity of the gases through the Forter regenerator will be of a more overall uniform average velocity than in a conventional type regenerator. Increasing the checker brick mass from checker bank to checker bank and reducing the cross sectional flue area in proportion to the reduced volume on account of the drop in temperature, will give a considerable less drop in velocity of the waste gases through the checkers than in the conventional type regenerator. The contraction or expansion of the waste gases or air being in direct proportion to the absolute temperature, the



PATENTS APPLIED FOR

CONVENTIONAL REGENERATOR
FIG. III

CHECKER CHAMBER VOLUME 1430 CU.FT.
WEIGHT OF CHECKER MASS LAID UP WITH 3"X6" FLUES-9"BRICK - 35¼ TONS

velocity curve going through the checker brick will parallel the temperature curve.

It will be noted that in the Forter regenerator an air preheat of 1900° F. is obtained and a waste gas temperature of 800° F. These are measured temperatures of the air and not radiant temperatures of the refractory side walls.

To those familiar with the design and operation of high temperature melting operations, this type of regenerator should be of interest. It is an advanced step in the regenerative furnace design. It has proven to be an efficient and economical melting unit with all parts accessible for inspection and quick repair.

In the design of this furnace, heat conservation and heat transfer have been considered of great importance. The melting chamber of the furnace is provided with a flat hanging arch to utilize the benefit of the laws of radiation and at the same time permit the correct furnace volume for correct combustion conditions.

The gas and air are supplied to the furnace under constant pressure and volume and in the proper relation to each other to give the proper rate of combustion. Sample flue gas analysis proved combustion to be practically complete.

A furnace of this design is consistently melting fifty tons of high quality soda-lime glass daily with an input of 324,000 cu. ft. of natural gas per day, or a fuel consumption of 6,480 cu. ft. of natural gas per ton. On this basis the output is one ton of glass per 8 sq. ft. of melting area per 24-hours.

While the present regenerators are in use with end port tanks in the arrangement as shown in Figure I., other arrangements are possible. Other arrangements are shown in Figures IV., V. and VI. It is also possible to use the Forter regenerator with side port tanks. Each port would be connected to a separate chamber and individually regulated as to gas and air supply.

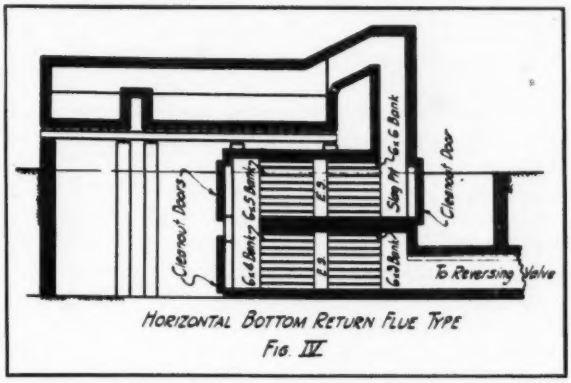
Figure IV. is very similar to Figure I. and is built where the space at the rear of the furnace would not permit the arrangement as shown in Figure I. Excavations and foundations in this case are more extensive.

Figure V. provides for vertical checkers. The hot bank of checkers receiving the first waste gases and carry over from the furnace may be easily replaced through large sliding doors located opposite the checkers. The vertical checker pass also gives a very effective chimney pressure, utilizes the checker temperatures for chimney draft with the result that the chimney may be of small diameter and height. In this design the air is introduced at the bottom of the reversing valve and the waste gas taken off at the top. This is in direct opposite to the customary flow through the reversing valve. This design is very suitable where space is not available and excavations are to be avoided.

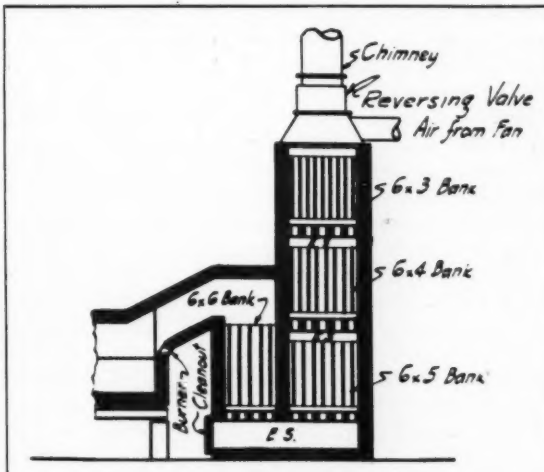
Figure VI. is similar to the arrangement shown in Figure V. with the exception that the waste gases are taken off at the bottom of the chamber and the first hot gases enter the first bank of checkers from beneath. This design is also suitable where space is not available and excavations are to be avoided.

The regenerators are built with cleanout doors for removal of slag and large door openings for resetting checkers. Radiation losses are reduced to a minimum.

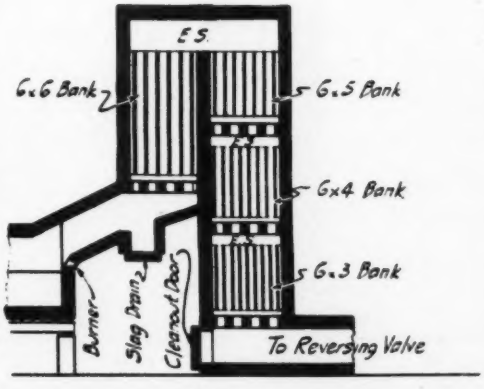
The intelligent use of any of the excellent refractories that have been made available to the furnace engineer during the past fifteen years will permit advanced designs to effect greater furnace efficiencies. Many of the existing furnaces are obsolete from the overall efficiency standpoint and can readily be converted to the most modern design. In most cases both quality and tonnage will be increased and fuel input greatly decreased.



HORIZONTAL BOTTOM RETURN FLUE TYPE
FIG. IV



VERTICAL FLUE TYPE, TOP DISCHARGE
FIG V



VERTICAL FLUE TYPE, BOTTOM DISCHARGE
FIG VI

WITH THE CONTAINER INDUSTRY

Glass Container Convention Provides a Remarkable Record of the Year's Accomplishments

THE recent meeting of the Glass Container Association at White Sulphur Springs, May 10 and 11, was perhaps the most successful in its history. Attendance was the largest it has ever been. The addresses, without an exception, were very interesting, filled with information, and covered an immense range of activity. The entertainment scintillated. A new Association record was hung up in the golf tournament. The industry was found to be operating at a high capacity. And everybody had a real good time.

Surely nothing more could be asked of a convention!

A report of Association activities by E. G. Ackerman, Assistant Business Manager, showed that the administration of the codes had kept all hands at headquarters busy since the mid-year meeting at Atlantic City. The glass container and cap industries had experienced less trouble however, than most; in fact, out of a total of 434 codes approved by the President to date, the glass code was number 36 and the cap code number 58, showing that the industry had its program under way among the very first in the country. In not a single instance had any manufacturer refused full and complete information to the staff of the Association, and the Code Authority had no occasion to report any complaints to Washington.

For the first time in its history, said Mr. Ackerman, a branch or subsidiary organization had been found necessary and this had been opened in San Francisco under the supervision of Mr. R. E. Kimball. Every factory on the Pacific Coast was now a member.

Victor Hall, Treasurer, presented a statistical report which depicts graphically the rate of activity in each branch of the industry. This will be found on page 81.

A labor survey had been made of the entire industry east of the Rockies, making it possible to supply comparative statistics for 1929, 1933, and 1934. The figures tabulated below show a payroll increase of nearly 7 per cent for March 1934 over the "prosperity" month of April 1929, and a 56 per cent increase over the low of April 1933. Over thirty-six per cent more employees are on the payroll today than in 1929 and some 57 per cent more than in 1933. The average hourly wage rate is now at an all time high of 52 cents, and compares with 42 cents in April 1933. Accompanying this, there has been a reduction in working hours of some 26 per cent.

The tabulation of this data follows. It covers automatic production only.

	April 1929	April 1933	Oct. 1933	March 1933
Total Factory Employees	16,163	14,049	20,048	22,047
Payroll Hours	815,109	648,802	742,892	824,443
Employees earnings per wk.	$402,478	$275,761	$380,995	$430,276
Average Hours per week	50	46	37	37
Average Hourly earnings	49	42	51	52

Great work has been done in the traffic department. The fight for a square deal on freight rates has been going on for so many years, it is hard to remember the beginning. Yet last September the railroads finally published parity ratings on glass packed products and the long controversy is over. More recently the Association has been fighting the celebrated Sand Rate Case. Although the Interstate Commerce Commission will not publish its decision probably before late summer, whatever the outcome, the Association has done everything humanly possible. Similarly an effort has been made to keep down rates on soda ash and limestone. In all of these cases, the Association has had the unstinted cooperation of the producers.

Karl Ford, Technical Advisor, made an impressive address covering the Damage Suit Racket. He showed how court decision after court decision had been rendered unfavorably to the glass container industry largely because the glass companies could produce no evidence of a standardized method of testing. As the picture now stands, the manufacturer is practically assumed guilty unless he can prove his innocence; and this is not always easy to do before the average jury. Since these law suits have been found a means to easy money, unscrupulous people are making almost a business of it. Mr. Ford made recommendations which he believed would help materially in bringing the situation under control.

C. P. Overmyer of the Standardization Committee cautioned container manufacturers again not to let the diameters of their finishes get down to the blue print minimum dimensions, but rather to strive for the mean dimension. He urged officials present to pass this word along so it would get to the factory workers themselves. He expressed the wish that the mould shop foreman could attend meetings of the Standardization Committee as great good would result from it. Mr. Overmyer also stated that the industry would shortly announce standards for cork finishes for wine and liquor ware.

W. S. Richards, Owens-Illinois Glass Company, and chairman of this same committee, stated that he had been receiving scores of blueprints lately relating to non-refillable bottles. The principal feature of these designs was that the act of removing the closure broke the finish and thereby made it impossible for the bottle ever to be sealed again. He pointed out that this would bring the consumer in contact with broken glass, making a finish of this type inherently dangerous to the industry.

During the past year there have been comparatively few tariff violations. For some months, however, there has been an increase in importations of all kinds of bottles, particularly low-priced perfume bottles from Japan. Another matter engaging the attention of the Tariff Committee had to do with the provision requiring the country of origin to be stamped on imported bottles. While this was mandatory on empty bottles, it had not yet been required of filled bottles.

Charles R. Stevenson, Business Manager of the Association, made a very convincing evaluation of N.R.A., with the framing of which he has been closely identified from the beginning. The Recovery Act, he pointed out, was designed to accomplish two things: First, a read-

(*Concluded on page* 98)

THE FIRST GLASS FILLING STATION

First Unit of Shell Oil Company's New Chain Presages Extensive Use of Glass in Building Construction

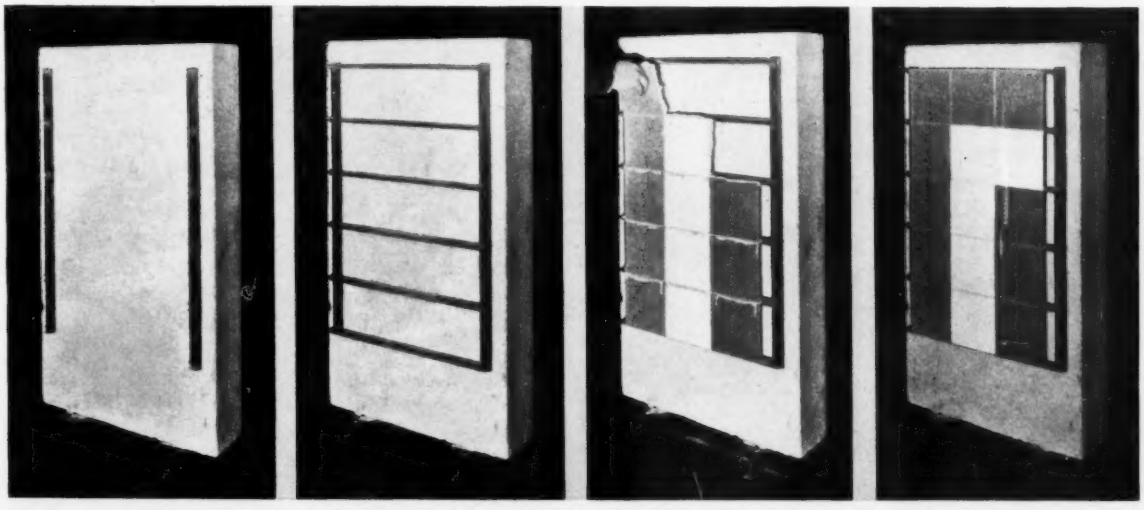
ON THE triangular plot of ground formed by the intersection of Morningside Avenue, St. Nicholas Avenue, and 124th Street, the Shell Oil Company is erecting the first glass filling station in this country. Other buildings of the same type will follow shortly—newspapers report the Shell Company is planning an entire chain of these glass filling stations to extend clear across the country. Several other of the big oil distributors have had drawings and estimates submitted. And in the offices of the Sealed Joint Products Company—designers, promoters and patentees of this steel-glass type of construction—are plans for theatres, restaurants and other semi-public buildings which will eventually materialize as structures of steel and glass.

It is not a coincidence that these early signs of what is generally considered a revival of building, should feature glass as the predominant construction material. For some years past, the trend in design, both for articles of merchandise and for structures, has been toward proportion of mass, simplicity of line, and economy and convenience of use. Color and color effects are factors, particularly in the field of illumination, whose influence will be felt even more strongly with the passage of time. And this whole spirit in design, which we have named the Modern, finds its most perfect expression through glass.

In Europe, most notably in Germany, the structural use of glass has been recognized and utilized far more than in the United States. In this country, building has been handicapped since 1929 by difficulties of financing; but steps taken by the Federal government (May, 1934) are intended to ease the credit situation quite materially.

Glass bricks and hollow tile are not entirely new in building. The most notable use of glass for building purposes was seen at the Century of Progress. However, the type of construction used in the Shell Oil filling station differs from these in that it consists of a flat glass tile supported by a steel framework. Macbeth-Evans Glass Company is so convinced of the practicability of the "Steelglass", as it is called, that it has spent time and money freely in perfecting the tile.

"Steelglass" makes possible the erection of modern structures as well as the renovation of existing buildings in a manner which is most simple of execution, a consideration of dominant importance in present-day construction. The process is as follows: mastic is placed on all four sides of each "V"-shaped, grooved glass unit; this unit is placed between horizontal steel ribs, called "purlins", which are fastened to uprights on a previous facing of brick, cement, or wood. The "grounds" are of 16-gauge mild steel, 1⅛″ by ⅜″; the tubular, spring-action purlins, of 22-gauge mild steel, measure ¾″ by ½″; the glass units are of three standard sizes: 4¼″ square, 4¼″ by 8½″, and 6″ square, all ⅜″ thick. The grounds are punched with ¼″ by ½″ slotted holes. Wood screws with washers, expansion bolts, or regular bolts with nuts and washers may be used to secure the grounds in place, depending on whether the backing is of wood, concrete, masonry, or steel frame work. The purlins and grounds may also be constructed in cadmium or chromium finish,



GLASS CONSTRUCTION IS SIMPLICITY ITSELF

Business can go on as usual while old interiors are modernized with walls of glass. These pictures show the successive steps in construction: (left to right) the "grounds" are secured to the cement base wall with expansion bolts. "Purlins" are secured to the grounds. The glass sections are inserted with mastic between the purlins. The finished panel.

or in copper-bearing steel, erado, richlow brass, aluminum, herculoy, everdure, or stainless steel.

The advantages of glass construction do not need to be pointed out to the industry; they should also be readily apparent to the layman. Some of the outstanding virtues of such construction are these:

Glass walls have light weight and yet great strength, the latter being furnished by a supporting steel frame and a continuous interlocking reinforcement on all four edges of each glass unit.

Glass walls are self-aligning and self-leveling the anchors and purlins force each unit of glass into position. Thus, construction is both easy and rapid. In building walls of the usual materials and by the usual methods, there is constant need for the use of plumb, bob, and level to maintain the exact width of joints, etc. Thus, complexity is reduced to simplicity in keeping with the modern trend.

Water drives through the joints of ordinary walls, causing serious damage to interiors and occasionally badly staining exteriors. Frequently their joints must be cleaned out and pointed up, and the wall waterproofed. Glass walls may always be mechanically sealed, thus eliminating expensive maintenance costs. Then again, glass does not age like ordinary facing materials; expenditures for redecorating and repainting are eliminated, or greatly reduced.

In modernizing or renovating standing buildings, glass is particularly useful in solving the difficult problems presented in facing walls. It is applicable to both exteriors and interiors, and where the units are to be applied to a backing of cement or brick, no scoring is required, a depth of ½″ being all that is necessary. The advantage of being able to utilize existing backing, thus lowering construction costs, and at the same time creating a new surface which adds greatly to appearance and efficiency, is of paramount importance to the prospective builder.

A double wall, faced with glass, may be strikingly illuminated. As the steel frame is set up, wiring and outlets are placed in the wall. At strategic points, concealed electric bulbs may be installed. Small access doors, also faced with glass, permit entrance from the inside to the lamps. There are unlimited possibilities for the utilization of such indirect illumination for novel advertising and striking appearance. For example, glass units of a different color from the predominant one may be so set as to spell out desired names or initials.

It should be mentioned, however, that the industry is faced with a major problem in the production of proper colors for these glass units. White, ivory, and green are, of course, standard colors, both translucent and opaque. Other colors may be created; but it should be remembered that buildings with glass walls have entirely different appearances by night and by day. In daytime, such a building is seen by sunlight and skylight *reflected from* the glass; at night, by incandescent light *transmitted through* the glass. Since Mazda light is much richer in red than sunlight or skylight, and since color appearances by reflected and transmitted light differ considerably (as an extreme example, gold leaf is yellow by reflected light, green by transmitted light), this difficulty is readily apparent.

Who are the prospective users of glass construction? In what types of buildings could glass be used to good purpose? The answer might well be: practically everyone, everywhere. Gasoline stations, theatres, restaurants, solariums, illuminated display signs, the interiors of show windows, bathrooms, kitchens, greenhouses, and office partitions suggest a few possibilities.

Assume that the owners of a filling station decide to adopt glass construction for their property. The immediate advantage would be these: they would find it quite easy to place the glass units upon already existing walls, quickly and easily. The walls would not stain, or become loose because of vibration, expansion and contraction having been allowed for in the "spring-grip" of the purlins and vertical anchor strips. The walls, after erection, could be easily cleaned and kept clean, a consideration of serious import in this particular business. Maintenance costs would be lowered. Sunlight could penetrate where it was wanted, imparting to the station an air of brightness and cleanliness. And last, but not least, indirect illumination would serve forcefully to advertise the station, and to enhance the general attractiveness of a clean, modern place of business.

The glass industry has a fertile field to develop. The research of the last few years is now beginning to pass the experimental stage. Business conditions are generally improving, construction figures are confidently expected to increase. Glass will add to the breath-taking beauty of modern buildings and rooms; it will help in focusing the spotlight of attention on the new, the up-to-date; it will exert a real influence on tastes and buying habits, thus widening the scope of its service to business and mankind, generally.

A. C. S. TO MEET IN BUFFALO

The 1935 meeting of the American Ceramic Society will be held in Buffalo, New York, the week of February 17, at the Hotel Statler. Announcement of the date and meeting place has just been made by Ross C. Purdy, general secretary from the offices of the Society in Columbus, Ohio.

DR. COHN BACK FROM ORIENT

Dr. Willi M. Cohn, consulting physicist, has just returned from a three months visit to the Far East and South Sea Islands. His homeward route brought him through Japan, where he writes he had the pleasure of meeting many prominent ceramists and enjoying their hospitality. Dr. Cohn visited several Japanese ceramic plants as well as the Imperial Ceramic Research Institute at Kyoto. He also lectured before the Japanese Ceramic Society. Dr. Cohn is now continuing his research and consulting work at Berkely, California.

SELLS WINDOW FOR OPTICAL GLASS

The Federal Trade Commission is closely watching the sale of optical goods and other apparatus which may have a bearing on health. Its latest action in this regard involved investigation of a company found to be selling lenses ground from window glass. A cease and desist order banning this and other fraudulent practices of the company has been issued by the Commission.

A READER WRITES

Editor GLASS INDUSTRY:

The kindly letter of Dr. Littleton, published in your May issue (p. 60), on the quality of the papers presented at the Cincinnati meeting, has only one weak spot. It may lead readers to suppose that the paper which was most severely criticised was the least satisfactory paper presented, but I do not think this was the case. The reason certain other papers were not criticised was because Dr. Littleton himself privately requested that they shouldn't be. So they were passed over in stony silence. Not a word of comment, favorable or otherwise, was made upon them. I feel sure some of these papers were much worse than those that were objected to.

As a matter of fact, violent criticism of a paper does not necessarily mean that a paper is lacking in good material. In the words of the two black crows, "even if it were good, I wouldn't like it" if presented at extravagant length and read verbatim with the nose buried in the script. Some University professors seem particularly obnoxious in this respect.

Papers to be good should be presented briefly, within the time limits allowed, and in conversational form. Recitations from the text sound like kindergarten affairs.

When several Divisions are meeting concurrently, it is most desirable that the time schedules be adhered to rigidly. Men may want to move from one division to another. This causes a lot of trouble when one Division gets behind schedule. The Refractories Division was just as bad as the Glass Division in this respect.

FRANK W. PRESTON.

CHANGES AT MARYLAND GLASS

Mr. J. S. Heuisler has resigned as Treasurer and General Manager of the Maryland Glass Corporation to accept the position of Field Sales Manager with the Emerson Drug Company. The Maryland Glass Corporation and the Emerson Drug Company are closely affiliated, Bromo-Seltzer, Incorporated, being the parent company of both. Mr. Heuisler will continue to contact in his new position many of the friends he has made in the trade through his connection with the Maryland Glass Corporation.

Miss E. M. Schulle has been made Treasurer of the Maryland Glass Corporation; L. C. Roche, General Factory Manager; and Philip I. Heuisler, Jr., Assistant Treasurer and Assistant Factory Manager.

CATALOGS RECEIVED

Savings Effected by Bailey Boiler Meters. Bailey Meter Co., Cleveland, Ohio.

This bulletin includes actual operating data showing the nature and amount of savings effected in typical installations of Bailey Boiler Meters. Various plant data and methods are included.

Temperature Control. The Brown Instrument Co., Philadelphia, Pa. have just issued an illustrated folder (85-10) showing the importance of automatic temperature control. Illustrations of various instruments are included.

Dust Hazards. A series of monthly folders dealing with "dust hazards" and then prevention is being issued by the Northern Blower Co., Cleveland, Ohio. It is planned to use data from various reliable sources and will be presented in a strictly unbiased manner.

"High Temperature Insulation". Johns-Manville Corporation, New York. Available on request.

A lecture used extensively by schools of mechanical, chemical metallurgical and ceramic engineering and now reprinted in the form of a 32 page, 3x9 pamphlet.

This lecture comprises a short review of the principles of heat transfer; a discussion of the theory and practice of insulation as applied to industry; charts and graphs on the conductivity values of insulation and refractories; insulation in boilers, kilns, oil stills, furnaces, regenerators and other typical industrial equipment operated at high temperatures. A standard formula for heat transfer by conduction and description of a method of determining heat flow through furnace walls are also included.

NEW PUBLICATIONS

Neon Tube Practice. Wil. Schalbreuter. London. Blandford Press Ltd. 1933. 132 pp. 10/6.

This volume contains both theoretical and practical information on the use of neon lights. The future of the neon tube is discussed. Illustrated.

Plastic Molding. L. F. Rahm. McGraw Hill Book Co., New York. 1933. 246 pp. $3.00.

This book discusses in detail the methods of fabrication of molded products and the equipment required. Physical characteristics of various plastics are reviewed. Details of mold design, mold fabrication, operating equipment and plant layout are given.

Inventions, Patents and Trade Marks. Milton Wright. N. Y. McGraw-Hill Book Co., 2d ed. 1933. 310 pp. $2.50.

This is a revision of the authors "Inventions and Patents". A chapter on design has been added and another on plant patents in addition to a set of rules regarding the drawing up of a royalty contract.

For the business man, chapters on trade marks, copyrights, damages and accounting have been added.

Thin-Section Mineralogy. A. F. Rogers and P. F. Kerr. N. Y. McGraw-Hill Co., 1933. 311 pp. $3.00.

This text is intended for those who wish to acquire some facility in the recognition of minerals in thin sections by the use of the polarizing microscope. The text is divided into two parts. The first deals with mineral optics and covers subjects such as preparation of thin sections, the polarizing microscope and the determination of optical properties of minerals. Part two contains descriptions of various rock-forming minerals.

Mechanical Transmission of Power From Motor Drive to Industry. Robert Drake N. Y. American Leather Belting Assn. 1933. 224 pp. 25 cents.

This book covers the practical plant application, operation, and maintenance of all kinds of motor drives including multiple V belts, belting, chains and gears. Covers trouble elimination and contains a wealth of practical information.

FOREIGN TECHNICAL PAPERS

TRANSLATIONS By S. R. SCHOLES

TEMPERATURE-VISCOSITY RELATIONSHIPS IN VERY FLUID GLASSES*

RELIABLE MEASUREMENTS of relations between temperature and viscosity for very fluid glasses have been rather infrequently carried out. W. H. Wadleigh[1] has reported briefly on American optical glasses. Since measurements of this sort may be of value in later observations on the constitution of glasses in the fluid condition, some data are presented.

Apparatus for measuring very fluid silicate melts: for example, blast-furnace slags in the range from 1 to 50 poises, are generally quite complicated (the Couette apparatus, after Margules). In what follows will be demonstrated a relatively simple means of carrying out comparative measurements with satisfactory precision, enabling us to recognize the great variations of viscosity as dependent upon temperature and chemical composition in the fluid region about 1350°.

Apparatus: The research of Endell, Müllensiefen, and Wagenmann[2] has shown that the suspended ball viscosimeter of Hänlein is unreliable for values below about 70 C.G.S. units (poises). The reason for this is to be found in the transmission of the motion of the ball to the reading-device by means of two pulleys. At low viscosities, the ratio of the friction of these pulleys to the excess of counter-weight necessary for moving the ball was too great. The data were thereby rendered uncertain or impossible. Likewise, the absolute amount of pulley-friction varied with increasing load in the weight-pan.

Müllensiefen had already proposed to obviate this error by substituting for the pulleys a balance-beam. The older system was satisfactory, however, for studying viscosities about 100 poises.

The task presented, that of measuring the viscosity of thinly fluid baryta glasses, made the introduction of the more sensitive balance beam necessary. The "light barium crown" (30.5% BaO), investigated by Wadleigh, reaches a viscosity of 57 poises as low as 1400°.

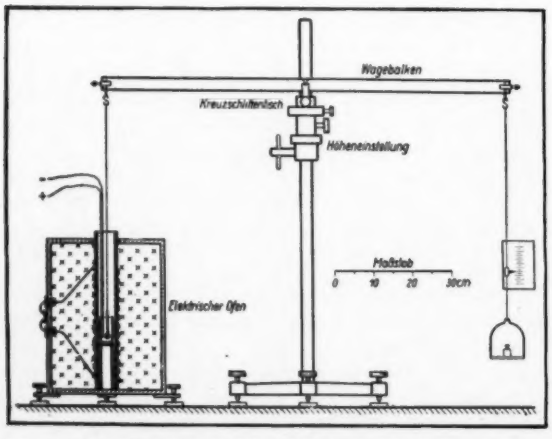


Fig. 1. Suspended-Ball Viscosimeter with Balance-Beam, for Silicate-Melts.

The composition of some of the glasses at hand indicated that still greater fluidity might be expected.

The arrangement developed for measuring these glasses is shown in Fig. I.

The electric furnace remains essentially unchanged. The platinum ball is a pendant upon the left side of a long balance-beam; the weight-pan is suspended from the right arm, with a pointer for scale-readings. The fulcrum of the balance is mounted movably on a cross-truck, making a positive centering of the ball in the melting crucible easily possible. Beneath the cross-truck is located a fine adjustment for height. The whole arrangement is adjustably mounted on a heavy stand. The arrest, which permits clamping the beam in any desired position, is omitted from the drawing for the sake of clearness. The beam is balanced so that its center of gravity is in the central knife-edge. The length of the beam renders sidewise movement of the ball negligible.

Calibration: The theoretical principles of the evaluation of measurements on the suspended ball-viscosimeter have been fully stated by Müllensiefen and Endell[2]. The viscosity is calculated according to a combined ball-cylinder equation, which (always assuming the same depth of bath and distance drawn) can be brought into the abreviated formula,

$$\eta = \frac{P}{V} \cdot K$$

where η = viscosity in C.G.S. units (poises),
P = over-load (excess counterpoise) in grams—in which the buoyancy of the ball and of the cylindrical rod in the melt must be considered,
V = velocity at which the ball is drawn in cm/sec,
K = a constant, which depends upon the dimensions of the platinum ball, the platinum rod welded thereto, and the height to which the crucible is filled.

Müllensiefen and Endell had found in the calibration of their apparatus that the equation

$$\eta = \frac{P}{V} \cdot k$$

must contain another constant factor, k^1, if absolute viscosity is to be found; thus

$$\eta \text{ absol.} = \frac{P}{V} \cdot k.k^1$$

This constant k^1 was determined experimentally by calibration with substances of known viscosity. It was a function of the measure of viscosity P/V and of the overload used in the measurements; that is, the quotient P/V, probably on account of the variation of pulley-friction with changing load, was not constant for unchanging viscosity.

*"Ueber Temperature-Zähigkeits-Beziehungen dünnflüssiger Gläser". By A. Tielsch and K. Endell, *Glastechn. Ber.*, March, 1934, p. 84.

1. *Bur. Stand. J. Res.* 1933, p. 65-78.
2. *Glastechn. Ber.* 11, 161.

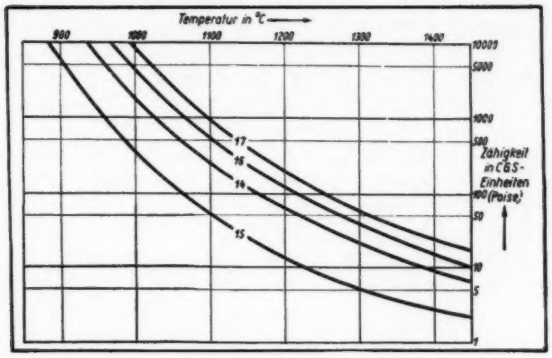


Fig. 3. Temperature-viscosity curves for several baryta glasses. (Schott & Co., Jena). See also Fig. 5.

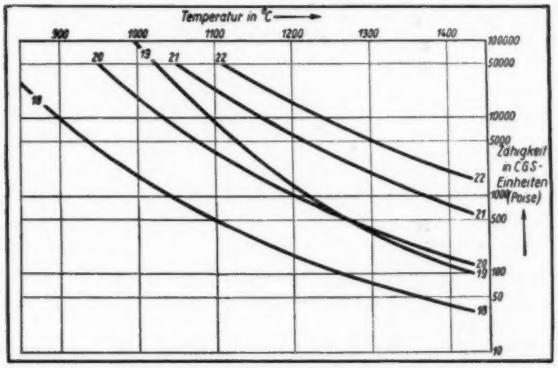


Fig. 4. Temperature-viscosity relationships of different glasses. (Schott & Co., Jena).

Preliminary experiments had shown that when the balance-beam is used, the quotient P/V, for uniform viscosity, is practically independent of the over-load. In the new method, then, the constant k^1 depends only upon the quotient P/V itself. The evaluation of viscosity measurements is thus greatly simplified. The dimensions of the crucible* and the ball, the depth of fill, and the measuring distance, were maintained constant. The absolute viscosity could then be calculated from the overweight P, the measured velocity V, and the experimentally determined constants, $k^1 \cdot k = K$, according to the equation:

$$\eta \text{ absol.} = K \cdot \frac{P}{V}$$

K, as depending upon P/V, was determined on two substances: (1) On a Thuringian glass investigated in an Osram viscosimeter and in our old apparatus, in the region of 50,000 to 200 poises. (2) On castor oil between 0° and 50° C, in the region of 70 to 1 poises. The value of K mounts from K = 5.8 and 1 poise to K = 19.0 at 50,000 poises. (Curves are presented, showing the close agreement between viscosities for the glass and oil as measured by the new method and calculated as above, and accepted values.)

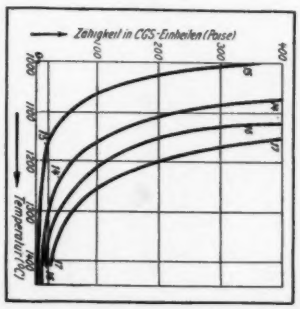


Fig. 5. Temperature-viscosity curves of the baryta glasses (compare Fig. 3) not logarithmically plotted.

The depth of the melt was held at 40 mm. The junction of the thermoelements, shielded from glass-attack by protection tube and platinum shoe, was located in the middle of the path of the ball. The variation of temperature in the melt at 1400° was ± 5°.

Two series of measurements were carried out on each glass: (a) with falling temperature, at intervals of about 100°; (b) with rising temperature, likewise at intervals of about 100°. The points of measurement in the second series were so chosen that, so far as possible, they came between those in the first series. The temperature-viscosity curve is therefore practically determined at 50 degree intervals.

The reproducibility of the results for viscosity by means of the balance-beam is:

Between	100,000	and	200	Poises, ± 5%
Between	200	and	50	Poises, ± 7%
Between	50	and	20	Poises, ± 10%
Between	10	and	1	Poises, ± 20%

Below one poise the measurement was too uncertain for quantitative results, as demonstrated with dilute glycerine. But the fall of viscosity below one poise can be shown, qualitatively, beyond question.

Results: Temperature-viscosity relationships were investigated, with the apparatus described above, for nine glasses which were placed at our disposal by the Jena Glass-works, Schott and Company. The temperature range covered was 850°—1450°. (Chemical compositions of the glasses are not definitely stated. Nos. 14, 15, 16 and 17 were barium-zinc boro-silicates, very low in alkali. No. 18 was a simple alkali-lead silicate. No. 19 was a barium-zinc-calcium boro-silicate, with 10-15 per cent alumina, and no alkali. No. 20 appears to be similar to the old "Geräteglas"— a soda-zinc boro-silicate, and No. 21 is like it, but lacks zinc and is higher in alumina. No. 22 had the highest silica content, with approximately equal amounts of baryta, soda, and alumina, and 10-15 per cent boric oxide.)

Fig. 3 portrays the extraordinary fluidity of baryta glasses at 1400°. It approaches in its low viscosity a blast-furnace-slag, rich in lime.

The glasses described by the curves in Fig. 4, in contrast with the baryta glasses, show very high viscosities. Thus, for example, the viscosity of glass No. 22 at 1400° is 700 times as great as that of No. 15!

The temperature-viscosity curves for the four baryta glasses investigated are shown to better advantage in Fig 5, where they are not drawn on a logarithmic scale.

Summary: 1. A simple and reliably workable suspended ball-viscosimeter with a balance-beam has been described, also its calibration. By its use viscosities between 1 and 100,000 poises, between 850° and 1450° C, can be measured with reproducible results. 2. The results of viscosity-measurements are reported on nine different glasses, whose viscosities at 1400° lie between 2.8 and 2100 poises. 3. The device is especially adapted for the estimation in a simple fashion of the influence of different metallic oxides upon the temperature-viscosity-relationships of glasses and slags throughout an extended range of composition.

*After each determination the platinum crucible was brought to its original diameter on a steel mandrel.

EQUIPMENT AND SUPPLIES

MEASURE ULTRAVIOLET RADIATION

Dr. M. Luckiesh and A. H. Taylor of the General Electric Lighting Research Laboratory have recently perfected a new Ultraviolet Meter that measures the biologically-effective ultraviolet content of the region between 2800 and 3200 Angstrom units. The unit of measurement used by the meter is the E-vitron. One E-vitron (10 mico-watts) per square centimeter, equals 1 erythemal unit.

The new Ultraviolet Meter is encased in a small portable cabinet, approximately 8 by 10 by 7 inches in size. It is equipped with a photoelectric cell which is connected to the meter by means of an extension wire. Inside of the cabinet is a vacuum tube hooked up with a sensitive counting relay.

In operation, the photoelectric cell, when actuated by the ultraviolet radiation, passes a small current which accumulates on a condenser until it reaches a sufficient quantity to "spill over" and turn the counting relay. This process is repeated as long as the photoelectric cell is exposed to ultraviolet.

At present the meter is being successfully used to measure the ultraviolet output of the G. E. sunlamps. Other uses suggest themselves, for example it may be used by physicians for checking ultraviolet dosages, weather bureaus may use it for determining the "useful" ultraviolet received by any location in a given period of time. Its uses in solariums and for checking ultraviolet transmitting glasses are obvious.

LAMP EFFICIENCY

A statement by the General Electric Company shows that the price of incandescent lamps has been reduced 58 per cent since 1921 while their lighting efficiency has increased 41 per cent in the same period.

NEW MERCURY-SWITCH CONTROLLER

The use of mercury switches to eliminate open make-and-break contacts controlled by the pointer, is a revolutionary feature of a new Automatic Control Indicating Thermometer announced by The Brown Instrument Company of Philadelphia, Pa. In this new Controller, every six seconds a motor-driven control table determines the location of the pointer in reference to the control setting, and tilts the mercury switch from one side to the other if the temperature has changed.

With this unique system, the measuring mechanism is free to position itself, unhampered by the control mechanism. There is no excess weight on the pointer, no distortion or restriction of pointer movement. The making of control contacts is not dependent upon friction, because the switch is positioned with a positive action by the electric motor. Contacts are unaffected by vibration because the mercury switch is mechanically locked in place until a different position is required. Corrosion and dirty contacts are eliminated as the switch is sealed in glass. These mercury switches have capacities up to 15 amperes at 110 volts (10 amperes at 220 volts), thus eliminating external relays in most applications.

This new Brown Indicating Controller is equally adaptable for control of pressure, liquid level, and similar factors, as well as temperature. Catalog 6702 completely describes this new line of controllers and will be sent promptly upon request addressed to The Brown Instrument Company, Philadelphia, Pa.

JOIN COMBUSTION ENGINEERING

William Lloyd, for many years identified with the design, manufacture and sales of Coxe stokers, has again become associated with the engineering department of Combustion Engineering Company, Inc., in much the same capacity of that of some years past. While Mechanical Superintendent for the Lehigh Valley Coal Company, Mr. Lloyd became interested in the development of the Coxe Stoker and was responsible for many of the earlier installations. In 1914 he became President of the Coxe Traveling Grate Company and later was made President of the Coxe Stoker Engineering Company which subsequently was affiliated with Combustion Engineering Corporation.

B. J. Cross, who from 1921 to 1931 was associated with the engineering activities of Combustion Engineering Corporation, rejoined the engineering department of the present organization, Combustion Engineering Company, Inc., on May first. He will be engaged in development and research work under the direction of John Van Brunt, Vice President in charge of engineering, and of Henry Kreisinger. Prior to 1921 Mr. Cross was with the U. S. Bureau of Mines and was identified with a number of notable investigations on the burning of fuels.

New Automatic Control Indicating Thermometer.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	..	.29
Hydrochloric (HCl) 20° tanks	Per 100 lb.	...	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.		.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext.	Per 100 lb.	5.50	...
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	...
Tartaric	lb.	.. Po. or Gr. / Cry.	.25 / .25½
Alcohol, denatured	gal.		
Aluminum hydrate ($Al(OH)_3$)	lb.	.04-.04½	.04½-.05
Aluminum oxide (Al_2O_3)	lb.	.04	.05
Ammonium Bicarbonate (f.o.b. works)	lb.	.05¼	...
(f.o.b. N. Y.)	lb.	...	.05¾
Ammonium bifluoride (NH_4FHF)	lb.	.15¼	.16
Ammonia water (NH_4OH) 26° drums	lb.		.02¾
Antimonate of Sodium	lb.	.09-.09¼	.10
Antimony, metallic (Sb)	lb.	.02½	.02¾
Antimony oxide (Sb_2O_3)	lb.	.085	.09
Antimony sulphide (Sb_2S_3)	lb.		.07
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	04	.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite)			
90%, 99% through 200 mesh	ton	56.50	61.50
90% through 100 mesh	ton	44.00	...
Barium hydrate ($Ba(OH)_2$)	lb.	.05	.05
Barium nitrate ($Ba(NO_3)_2$)	lb.	...	.08¾
Barium selenite ($BaSeO_3$)	lb.	...	1.50-1.75
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Bone ash, carlots	lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	...	...
Granulated	In bags, lb.	.02	.02¼-.02½
Powdered	In bags, lb.	.02¼	.02½-.02¾
Boric acid (H_3BO_3) granulated	In bags, lb.	.04¼	.04½-.04¾
Cadmium sulphide (CdS)—	lb.	...	.70-.75
Chromite	lb.	...	.215
Chrome oxide Green	lb.	...	.215-.25
Cobalt oxide (Co_2O_3)			
In bbls	lb	..	1.25
In 10 lb. tins	lb.	...	1.35
Copper oxide			
Red (Cu_2O)	lb.	...	.25
Black (CuO)	lb.	...	.17-.19
Black prepared	lb.	..	.22
Cryolite ($Na_3Al F_6$) Natural Greenland (Kryolith)	lb.	.08½	.09
Synthetic (Artificial)	lb.	.08	.085
Epsom salts ($MgSO_4$) (imported) technical	Per 100 lb.	...	2.40
Feldspar—			
40 mesh	ton	10.50-12.75	
20 mesh	ton	10.00-12.25	
Granular	ton	10.75-13.00	
Semi-granular	ton	10.00-12.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	28.23-35.00	...
In bags	ton	29.83-36.60	40.60
Imported (f.o.b. Seaboard)	ton	31.00	...
Formaldehyde	lb.	.05	.07
Graphite (C)	lb.	...	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	...	.0425
Black (Fe_3O_4)	lb.	.04½	..
Iron chromate	lb.	...	.035-.05
Kaolin (f. o. b. mine)	ton	8.00-9.00	...
English, lump, f. o. b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	...	.30
Lead oxide (Pb_3O_4) (red lead)	lb.	.0650	.0775
Litharge (PbO)	lb.	.0550	.0675
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	...
Burnt (CaO) ground, in bulk	ton	7.00	...
Burnt, ground, in paper sacks	ton	9.00	...
Burnt, ground, in 280 lb. bbls	Per bbl.	2.15	2.30
Limestone ($CaCO_3$)		1.75-2.50	...
Magnesium carbonate ($MgCO_3$)	lb.	.06	.08-.09
Magnesium Sulphate (U.S.P.)	lb.	...	.03
Manganese, Black Oxide			
In Paper bags	ton	45.00	..
In Burlap bags	ton	46.50	51.50
In Casks	ton	48.00	53.00
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	...	.35-.40
Nickel monoxide (NiO), green— for nickel content	lb.	...	.35-.40
Plaster of Paris, bags	ton	31.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.08½	.08½
Powdered	lb.	.095	.105
Potassium carbonate	lb.	.0825	.0875
Calcined (K_2CO_3) 96-98%	lb.		
Hydrated 80-85%	lb.	.07¼	.0775
Potassium chromate (K_2CrO_4)	lb.		.14¼
Potassium hydrate (KOH) (caustic potash)	lb.	.07¼	.09
Potassium nitrate (KNO_3) (gran.)	lb.	...	.06-.06¼
Potassium permanganate ($KMnO_4$)	lb.	.18½	.19
Powder blue	lb.	...	.18-.45
Rochelle salts, bbls	lb.	...	.12½
Rouge	lb.	... Po. or Gr. / Cry.	.13½
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	18.00	27.00
Selenium (Se)	lb.	...	1.80-2.00
Silver nitrate (AgNO)	(100 oz.) per oz.	..	.31
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb.	1.10	...
In barrels	Per 100 lb.	1.50	...
In bags	Per 100 lb.	1.25	...
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¾	.08
Sodium fluosilicate (Na_2SiF_6)	lb.	.04¾	.05-.06
Sodium hydrate (NaOH) (caustic soda)			
Flake	Per 100 lb.	3.00	...
Solid	Per 100 lb.	2.60	...
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls	lb.	...	2.25-2.50
95 per cent	Per 100 lb.	1.195-1.295	1.245-1.345
Sodium selenite (Na_2SeO_3)	lb.	..	1.80-2.00
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.50-1.55
Sodium Uranyl Carbonate	lb.	...	.80-.90
Sulphur (S)—			
Flowers, in bbls	Per 100 lb.	3.45	3.70-4.05
Flowers, in bags	Per 100 lb.	3.10	3.35-3.65
Flour, heavy, in bbls	Per 100 lb.	2.85	3.20-3.45
Tin chloride ($SnCl_2$) (crystals) in bbls.	lb.	...	.385-.42
Tin oxide (SnO_2) in bbls	lb.	...	.57-.60
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	...	2.75
Yellow orange	lb.	...	1.55
Zinc oxide (ZnO)	lb.	.08½	.12
American process, Bags	lb.	.065	.0675-.075
Zircon			
Granular (Milled .005-.02c higher)		.07	.67½-.08
Crude, Gran. (Milled .005-.02c higher)		.03½	.04-.05

CANS WITH GLASS WINDOWS

The inherent suitability of glass as a container for food products has again received confirmation by the recent appearance of tin cans with a glass end. Recognizing that the opacity of the tin can was one of its major drawbacks, Continental Can Company recently tried the experiment of inserting glass discs into the top of the can by which the consumer could see the food. A two day test made in Chicago retail grocery stores, showed that sales increased over 300 per cent.

These cans presented quite a manufacturing problem. Since canned foods require considerable heat treatment for sterilization, the glass had to be sufficiently strong to withstand processing temperatures as well as the

shock from subsequent cooling. Danger from broken glass must be avoided at all costs. The manufacture of the glass discs and their insertion into the can end was therefore turned over to Corning Glass Works. By the use of heat resistant pyrex these difficulties were overcome, although it was not a simple matter to secure an adhesive that would hold the glass firmly into the tin and also preserve an air tight seal under all conditions.

CLASSIFIED ADVERTISEMENTS

FIVE EXPERT OPERATORS WANTED. On automatic glass blowing J-P Machines of the Edward Miller Company, for service in the U.S.S.R. Apply to Amtorg Trading Corporation, 261 Fifth Avenue, New York City. Box 20, THE GLASS INDUSTRY.

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FOR SALE: Large quantity of Kirk & Blum wind cooling pipe, various sizes. Extremely low figure. Box 18, THE GLASS INDUSTRY.

DOINGS OF THE CONTAINER INDUSTRY

(*Continued from page* 90)

justment of work hours and wages, and secondly, industrial self government. Both of these principles were fundamentally right. Manufacturers should be willing to cooperate in improving the position of labor; in return they should insist on the right of self government.

The trouble at present, said Mr. Stevenson, was that these fundamental concepts involved in the Recovery Act had become confused with other issues. Into the problem of wages, for instance, the labor union question had been injected. Because of the muddle, business men were throwing up their hands at the whole affair.

The Association will be led next year by the same officers and directors, all of whom were re-elected. C. Dudley King of the General Glass Company, was chosen as a new director to fill the unexpired term of R. E. Walker, resigned.

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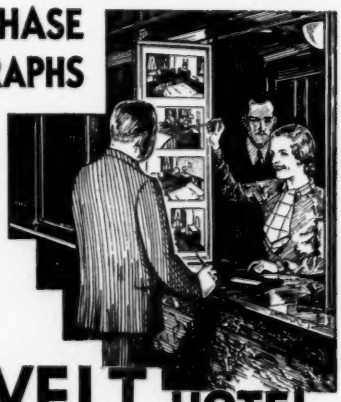

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